



# Surgery, Gynecology and Obstetrics

An International Magazine  
Published Monthly

---

## *EDITORIAL STAFF*

FOR AMERICAN COLLEGE OF SURGEONS

WILLIAM J MAYO, M.D

GEORGE W CRILE, M.D

JOHN M T FINNEY, M.D

WALTER W CHIPMAN, M.D

HARVEY CUSHING M.D

J BENTLEY SQUIER, M.D

WALLACE I. TERRY, M.D

PHILIP H. KREUSCHER M.D

WILLIAM H WILMER M.D

CHARLES H FRAZIER, M.D

FREDERIC A. BESLEY M.D

WILLIAM R. CUBBINS M.D

DONALD C. BALFOUR, M.D

ROBERT B GREENOUGH M.D

ALTON OCHSNER, M.D

FOR THE BRITISH EMPIRE

LORD MOYNIHAN K C M G C.B. M.S., F.R.C.S

A JAMES WALTON M.S. F.R.C.S

THOMAS W EDMOND M.D. F.R.C.S

GEORGE GREY TURNER M.S. F.R.C.S

DAVID P D WILKIE, M.D. F.R.C.S.E

SIR WILLIAM I DE C WHEELER M.D., F.R.C.S.I

FRANKLIN H. MARTIN, M.D., Managing Editor

ALLEN B KANAVEL, M.D., Associate Editor

LOYAL DAVIS, M.D. Associate Editor

VOLUME LVIII

JANUARY TO JUNE 1934

PUBLISHED BY  
THE SURGICAL PUBLISHING COMPANY OF CHICAGO  
54 EAST ERIE STREET CHICAGO

1934

Copyright by  
THE SURGICAL PUBLISHING COMPANY  
OF CHICAGO  
1914

# CONTRIBUTORS TO VOLUME LVIII

ABELL, IRVIN	430	COLEY WILLIAM B	471	HARRINGTON STUART W	440
ABRAMSON DANIEL	595	COPE, OLIVER	255	HARVEY SAMUEL C	791
AGNEW G HANVEL	547	COUNSELLER VIRGIL S	239	HASKELL, BENJAMIN	651
ALKEE, FRED H	509	CRILE, GEORGE W	272 541	HATCHER, ROBERT A	823
ALLEN ARTHUR W	79	CROSEN HARRY S	450	HEALY WILLIAM P	452
ALLEN J HALL	651	CROWELL, BOWMAN C	516 520	HEDBLUM, CARL A	503
ANDERSON ROGER	639	CUBBINS, WILLIAM R	129 320	HELLWIG C. ALEXANDER	145
ANDREWS, EDMUND	753	CUTLER, MAX.	285	HINMAN FRANK	356
ANDSPACH BROOKE M	448			HIRSFIELD SAMUEL	886
AUFER, ARTHUR H	886	DANN, D B	546	HOUGH GARRY DEN JR	972
		DAVIES JOSHUA WILLIAM	70	HOWES, EDWARD L	136
BAGLEY, CHARLES, JR	498	DAVIS, CARL HENRY	455 919	HRYNCHIAK THEODOR	103
BALFOUR, DONALD C	795 917	DAVIS LOTAL	13 398	HUNT ARTHUR B	906
BANCROFT FREDERIC W	476 531	DE TAKATS GEZA	310 655	HUTCHINS, ROBERT MAYNARD	420
BARRINGER, BENJAMIN S	867	DICKSON FRANK D	550		
BARTLETT WILLARD	737	DIXON CLAUDE F	462	IRVING FREDERICK C	1
BARTLETT WILLARD JR	737	DOUGLASS, MARION	982		
BENEDICT EDWARD B	79	DRAOSTEDT LESTER R	276	JACKSON ARNOLD S	590
BENEDICT WILLIAM L	383	DUKE CHARLES A.	426 545	JACKSON CHEVALIER	431
BERMAN, SAUL	1			JOHNSON C GORDON	113
BIRNEY FREDERIC A	490 533	EASTON EDWARD RAYMOND	762	JOHNSON JOSEPH E.	897
BILLING, WALTER L	539	ECKEL, JOHN L	120	JOHNSTON C. R. K	614
BISCARD J DEWEY	817	ELLISON E. L	85	JONES, HUGH T	178
BISSELL, ARTHUR D	753	ELKIN DANIEL C	1044	JUDD E. STARR	440 781
BLACK, CARL E	242	ESTES, WILLIAM L. JR	482		
BLAIN A. W	543	EWING, RUTH E	192	KANAVEL, ALLEN B	424 668
BLALOCK, ALFRED	531			KEGARIES, DONALD L	46
BLOOM, DAVID	827	FAY TEMPLE	797	KENNEDY ROBERT H	479
BOLAND FRANK K	427	FERGUSON L. K	85	KEY J ALBERT	166
BOYCE, FREDERICK FITZGERBERT	32	FLOOD CHARLES A	136	KETTER, EDWARD L	233
BRAACH, WILLIAM F	647	FRASER, JOHN	171	KILGORE, ALSON R	434
BRODERS, ALBERT C	100	FREEDMAN NATHAN	717	KRETSCHMER, HERMAN L.	381 460
BROWN GEORGE E	297	FREEMAN NORMAN E.	956	KREUSCHER, PHILIP H	397
BROWN ROBERT L	956				
BUTLER, VIRGINIA W	57	GAETLEN FREDERICK J	511	LAHEY FRANK	238
		GALLIGAN JOHN J	428	LAPIDUS, PAUL W	183
CALDWELL, BERT W	540	GAMBLE, RICHARD C	389	LEWY HAROLD G	679
CALLAHAN JAMES J	129	GATES, OLIVE	962	LEIGH B C	547
CAMPBELL, WILLIS C	116	GELLHORN GEORGE	456 879	LE MOYNE, MARGUERITE	192
CAREY ELEN J	541	GERRISON-COHEN J	52 935	LEVERING J WALTER	699
CAULK JOHN R	341	GORMLEY R. K	793	LEWIS, MARSH T	545
CECIL, ARTHUR B	639	GILCREST EDGAR LORRINGTON	322	LOHR, OLIVER W	549
CHORONSKI JERKY	12	GLENN ROBERT A	548	LUND CHARLES C	433
CHRISTOPHER, FREDERICK	903	GOODALL, JAMES ROBERT	882 1048		
CHURCHILL, EDWARD D	255	GREENMOUGH, ROBERT B	437 516	MACAUSLAND ANDREW R	679
CLARK GEORGE L	578	GRISWOLD R. A.	900	MACAUSLAND W RUSSELL	679
CLIFFORD STEWART H	727 959			MACKENZIE, WALLACE D	655
CLOFTON MALVERN B	438	HAGGARD WILLIAM D	410 415 541	MAES URRAN	32
COFFEY ROBERT C	465	HAIGHT CAMERON	768	MAINBOT RODNEY	62
COHN ISIDORE	485	HAMMOND T E	745	MARTIN FRANKLIN H	
COLEY BRADLEY L	471	HARDWICK, ROBERT S.	1018		



MARON, JAMES M	442	POOLASKY, H. B.	543	STIMSON, BARBARA B.	1007
MARON, MICHAEL L.	507	POE, JAMES G.	711	STONE, HARVEY B.	1027
MARSON, JAMES C.	453 1036	POOK, EDMUND H.	436	SWENSON, PAUL C.	1007
MATSON, RALPH C.	619	PRIESTLEY, JAMES T.	1030		
MAYO, WILLIAM J.	671	PULLI, VITTORIO	318	TAYLOR, GRANTLEY W.	914
MCCARTHY, JOSEPH FRANCES	377			TERHANT, ROBERT	968
MCNEELY, ALBERT E.	786	RALLI, CLAUDE P.	218	THOMAS, WILLIAM G.	823
McPETERIDGE, ELIZABETH M.	35	RANDY, ELIZABETH M.	968	THOMPSON, KENNETH WADE	852
MCLANAHAN, SAMUEL	1017	RANDALL, LAWRENCE M.	10 8	TINKER, MARTIN B.	468
MCLAUGHLIN, CHARLES W. JR.	699	REID, MONT R.	257 669	TUCKER, CLAUDE C.	145
MCNEELY, R. W.	310	REMY, CHARLES E.	546	TYRONE, CURTIS H.	113
MENFERTY, WILLIAM F.	150	RENTLE, H. M.	276		
METTER, SAMUEL J.	303	ROBERTS, SUMMER M.	595	VICTOR, JOHN A.	436
MOORE, HERMAN J.	781	ROBERTSON, D. E.	312		
MOORE, BEVERIDGE H.	321	ROYSER, HUBERT A.	1040	WALSH, WILLIAM H.	544
MOORE, JOHN T.	443			WALTERS, WALTER.	647 1030
MUMFORD, L. BISHOP	104	SCHLUTTER, ROBERT E.	921	WANGENSTEIN, OWEN H.	118
MURPHY, DOUGLAS P.	150	SCHREINER, HERMAN F.	1021	WARD, GEORGE GRAY	67
		SCHWETZALL, ALPHONSE M.	533	WARREN, SEYMOUR	962
NELSON, H. BRISTOL	1	SCOTT, W. W.	215	WATSON, WILLIAM JAMES	762
NEUFY, HAROLD	886	SCUDDER, CHARLES L.	474	WAUGH, JOHN M.	841
NEW, GORDON B.	841	SCUDERI, CARLO S.	129	WEBER, WILLIAM H.	1021
NEWELL, QUITMAN U.	490	SEELIG, M. G.	395	WEIL, ARTHUR	807
NEWQUIST, M. N.	493	SEAY, HARRY	52 935	WEIR, FRANCES	549
NEWTON, MARY M.	549	SHEPHERD, WILLIAM O'NEILL	597	WHITE, JAMES C.	923
NICKEL, ALEXANDER	206	SEWELL, B. R.	394	WHITE, S. MARK	542
NILSSON, JOHN R.	514	SMITH, CLINTON	543	WHITTINGTON, H. BECKWITH	272 447
NOBLE, CHARLES C.	452 741	SMITH, RICHARD R.	446	WIDGER, MEYER	399
		SPEED, KELLOGG	330	WILLIAMSON, E. W.	496
PACK, GEORGE T.	248	SPRING, WILSON	705	WILSON, HUGH M.	995
PAERIS, WILLIAM R.	634	SQUER, J. BENTLEY	407 531	WILSON, PHILIP D.	595
PEARCE, RICHARD L.	845	STANDARD, SAMUEL	218	WITHERSPOON, J. THOMAS FILL	37
PECKHARTON, JOHN DEJ.	100 462	STEIN, IRVING F.	567		
PENFIELD, WILDER	1041	STERNBERG, A.	487	YOUNG, FORREST	986
PEPPER, DAMON B.	435	STEPHENSON, GEORGE W.	1036		
PILCHER, CORA	995	STEWART, M. A.	155	ZIGLER, PAUL F.	578

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVIII

JANUARY, 1934

NUMBER 1

## THE BARBITURATES AND OTHER HYPNOTICS IN LABOR<sup>1</sup>

FREDERICK C. IRVING M.D., F.A.C.S., SAUL BERMAN M.D. AND H. BRISTOL NELSON M.D. BOSTON

NUMEROUS reports have appeared in the literature concerning the use of various drugs to relieve the pains of labor. Such studies have been confined only to the effects of one drug or combination of drugs but have never embraced a critical comparison of different methods applied to equal groups of similar unselected patients in the same institution.

On July 1, 1931, at the Boston Lying in Hospital was begun an investigation into the anesthetic, analgesic, and anesthetic properties in labor of drugs already in more or less common use, as well as other agents not at that time often employed for the same purpose. To this end two specially trained graduate nurses, one for day and one for night duty, were engaged to assume immediate charge of the patients under investigation. These nurses were required to keep detailed and extensive anesthetic records of each patient upon forms provided for the purpose. This work was made possible through the generosity of Mrs. Albert C. Burrage, to whom the authors wish to express their gratitude.

The investigation was completed 1 year later, and the results obtained are the basis for this report. Eight hundred and sixty patients were studied and eight types of anesthesia were used. These were pantopon and scopolamine, pantopon and rectal ether, pernocton, sodium amytal and scopolamine, pen-

tobarbital and scopolamine, sodium amytal and rectal ether, pentobarbital and rectal ether and pentobarbital and paraldehyde. There were 100 cases in each series except in the group in which sodium amytal and scopolamine were employed and this consisted of 160 cases. During the expulsive stage nitrous oxide and oxygen was given all patients, ether being added on the rare occasions when it was required.

The first essential in any method for the relief of the pains of labor is absolute safety for both mother and infant. None of our 860 patients died or was in any way adversely affected. No serious pulmonary or other complications were noted during labor or in the puerperium. Since the barbiturates have considerable effect in diminishing reflex responses they should not be used when the patient has any infection of the upper or lower respiratory tract. For the same reason they should be avoided when the patient has recently eaten, since vomiting may occur with danger of aspiration of the vomitus. The uncorrected stillbirth rate was 0.93 per cent, which compares favorably with a rate of 1.4 per cent during 1920, a year selected at random for comparison, since at that time no analgesic drugs were in systematic use in the hospital. Seven infants were stillborn. The cause of stillbirth and the type of anesthesia used in each case is shown in Table I.

<sup>1</sup>From the Department of Obstetrics, Harvard Medical School, and the Boston Lying-in Hospital.

TABLE L—STILL BIRTHS IN 866 DELIVERIES

Hospital Admission Number	Cause of stillbirth	Method of examination
40113	Knot in cord (low forceps delivery)	Postabortal and scopolamine
40904	Fetal heart rate rapid before delivery. Baby passing meconium. Difficult operative delivery (low forceps)	Pantopon and scopolamine
40214	Intra uterine asphyxia. Fetal intracranial hemorrhage (seton)	Bothen anesthetic and scopolamine
5 11	Anencephalic monster	Postabortal and scopolamine
30087	Cord three times about neck tightly	Bothen anesthetic and rectal ether
31506	Baby passing meconium. Fetal heart not heard before delivery (low forceps)	Postabortal and rectal ether
31046	Baby passing meconium. Cord tightly about neck. Microscopic examination of placenta showed premature separation with calcification, thrombosis, and hemorrhage	Postabortal and rectal ether

It was our aim to produce complete amnesia from the time the drugs were first administered until the patient awoke in bed in the ward so that there would be no memory whatever of her labor. We wish to make it clear that simple amelioration of suffering which has seemed to satisfy many writers, notably those who have employed morphine and rectal ether, would be classified by us as a failure or at best as only a partial success. In Chart 1 are shown the results obtained in producing amnesia.

It is highly desirable that excitement should be minimal since a restless patient is difficult to control and unless constantly watched, may do herself an injury. Since many of the drugs we used were likely to cause excitement particularly with the onset of each uterine contraction this element proved of considerable importance. No patient in labor who is given any hypnotic drug should ever be left, even momentarily without constant competent nursing supervision. No such medication should be administered when labor is conducted in the patient's home. It is an affair for a hospital alone, and all relatives and friends must be excluded from the room. No patient, at completion of labor, should be left until she is thoroughly awake and able to answer questions intelligently (Chart 2).

#### PANTOPON AND SCOPOLAMINE

Since morphine and scopolamine or twilight sleep and morphine and rectal ether

are the two methods which have been most largely used, we first directed our attention to them. We substituted pantopon for morphine in both groups, since it has been stated that this preparation of opium is less toxic to the fetus *in utero*. One hundred patients were given pantopon and scopolamine. All cases in this series, as in the 7 others, were unselected, the drugs being administered to any patient entering the hospital who presented no major abnormality. The initial dose of pantopon was one third of a grain. One hundred and fiftieth of a grain of scopolamine was given 45 minutes later and the scopolamine was repeated in the same dosage as often as was necessary to dull the sensorium. Medication was begun in primiparae when the cervix was two fingers dilated and the uterine contractions coming every 3 to 5 minutes and lasting 45 seconds. Multiparae received the same medication regardless of the condition of the cervix when the pains were coming with the same frequency and lasting for the same time. The pantopon was never repeated. The disadvantages of this method proved considerable. Only 39 per cent of patients enjoyed complete and 34 per cent partial amnesia, while in 27 per cent no relief at all was experienced. The degree of excitement was moderate. 10 per cent of the patients required control. There also seemed to be an increase in the frequency of postpartum hemorrhage, since 25 per cent lost over 300 cubic centimeters of blood (see Table VII).

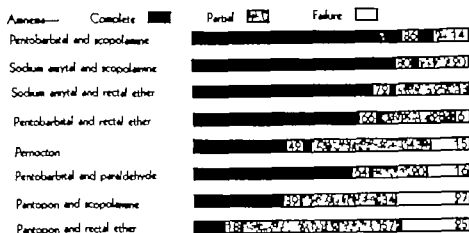


Chart 1 Effect of the drugs in producing amnesia.

The effect on the babies was striking. Only 33 per cent breathed immediately at birth (Chart 3). The balance required the removal of mucus or various methods of resuscitation.

A study of cases in the Outpatient Department, where no anesthetics are used during normal delivery, revealed that only 19 per cent of the living full term infants did not breathe immediately as soon as they were born. A similar study of patients delivered in the hospital to whom only gas-oxygen and ether were given showed that 80 per cent of infants made their initial respiration as soon as they were delivered.

Table V indicates that in primiparae labor was on the average prolonged when pantopon and scopolamine were employed. There was also an increase in the average interval between the first medication and delivery in primiparae as shown in Table VI. This prolongation is all the more striking, since these drugs were not administered until labor was definitely under way, as was evidenced by two fingers dilatation of the cervix, and an interval between uterine contractions of from 3 to 5 minutes with a duration of 45 seconds. No such effects were evident with multiparae.

There was moreover, an operative incidence of 46 per cent, the highest in any method we used.

#### PANTOPON AND RECTAL ETHER

A modification of the so called Gwathmey synergistic analgesia was next studied. An initial dose of one third of a grain of pantopon with 2 cubic centimeters of 50 per cent mag-

nesium sulphate solution, was administered. Twenty minutes later 2 cubic centimeters of magnesium sulphate solution was given with out the morphine. In 20 minutes to 1 hour the usual dose of rectal ether, quinine, and olive oil was given by rectum and accompanied by another intramuscular injection of 2 cubic centimeters of magnesium sulphate solution. The rectal ether was repeated every 3 to 4 hours if necessary. From the point of amnesia this method proved to be the least satisfactory, since only 18 per cent of our patients in the series of 100 cases experienced complete and 67 per cent partial loss of memory. There were 25 per cent of failures. The incidence of excitement however, was low, there being only 4 per cent who required restraint. Blood loss of over 300 cubic centimeters occurred in 16 per cent of the cases. The effect on the baby was not as marked as that of pantopon and scopolamine, since 53 per cent breathed immediately at birth. As a result of the study of these two series of cases we believe that morphine or any of its derivatives has no place during labor as they distinctly delay the initial respirations of the child. While no infants were lost because of the administration of pantopon to their mothers, the period of time which elapsed between their birth and their first breath was on many occasions sufficiently prolonged to cause the obstetrician considerable anxiety.

#### PERNOCTON

We next used pernocton (10 per cent aqueous solution of the sodium salt of the second

## EXCITEMENT

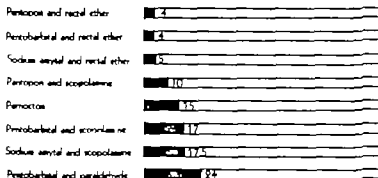


Chart 2. Effect of the drugs in producing excitement.

ary butyl beta-bromamyl barbituric acid) in 100 cases. This drug is administered intravenously. Since, if it escapes into the tissues, it may produce necrosis it should be administered only by a physician. The dose employed was 1 cubic centimeter per 30 pounds of body weight, given at the rate of 1 cubic centimeter every 2 minutes. The average dose was from 4 to 6 cubic centimeters. It was repeated if necessary at the end of 3 hours in half the original dose.

By referring to Tables V and VI it will be noted that with this drug the average length of labor was not shortened in primiparae but was somewhat shortened in multiparae. The average time interval between the first medication and delivery was, however, notably decreased in both types of patients. This is accounted for by the fact that the action of pemoxon is evanescent and can be given only at the end of the first stage of labor. Only 42 per cent of our patients experienced complete amnesia although 43 per cent had some relief. Fifteen per cent were unduly excited, and 15 per cent exhibited convulsive movements after receiving the drug. So far as the babies were concerned the effect was similar to that of pentopon and rectal ether since only 53 per cent breathed immediately at birth. We consider that this drug is not suitable for use during labor.

## SODIUM AMYTAL AND SCOPOLAMINE

The study of sodium amytal (sodium iso-amyl-ethyl-barbiturate) and of pentobarbital (sodium ethyl [1 methyl-butyl] barbiturate)

in combination with scopolamine or rectal ether was next undertaken. There were 160 patients who received sodium amytal and scopolamine. The initial dose of sodium amytal by mouth was from 9 to 12 grains depending upon the weight of the patient. This drug was repeated 3 to 4 hours later in from 3 to 6 grain doses if indicated. Forty five minutes after the initial dose of sodium amytal one one hundredth or one one-hundred and fiftieth of scopolamine was given subcutaneously and was repeated later as soon as the patient began to complain of pain. The resultant amnesia was highly satisfactory. 80 per cent remembering nothing of their labors and 20 per cent recalling only isolated incidents. There were no failures. There was, however, a rather high degree of excitement since 17.5 per cent required restraint. The effect on the baby was good since 61 per cent breathed immediately. There was also a comparatively low operative incidence.

## PENTOBARBITAL AND SCOPOLAMINE

Pentobarbital and scopolamine were used with 100 of the patients. We found that our patients regained consciousness much earlier after delivery than those who had received sodium amytal and scopolamine, and therefore required less postpartum watching. The initial dose is from 4.5 to 6 grains by mouth which may be increased if desired and it is repeated according to the same indications as govern the use of sodium amytal. The best results in amnesia were obtained by this method, since 86 per cent remembered

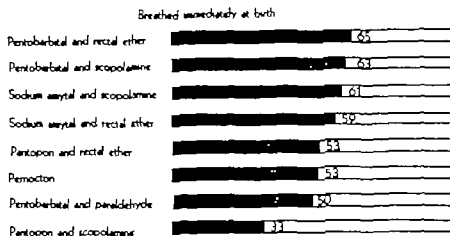


Chart 3 Effect on initial respirations of infants.

nothing of their labor and 14 per cent recalled only isolated incidents. Sixty three per cent of the children breathed immediately at birth.

#### SODIUM AMYTAL AND RECTAL ETHER

Rectal ether was then combined with sodium amytal and with pentobarbital. Sodium amytal and rectal ether were given to 100 of the patients with 72 per cent complete and 25 per cent partial amnesia and 3 failures. Fifty nine per cent of the babies breathed immediately at birth.

#### PENTOBARBITAL AND RECTAL ETHER

One hundred patients received pentobarbital and rectal ether. Amnesia was complete in 66 per cent and partial in 28 per cent. There were six failures. It therefore appeared to be somewhat less effective than sodium amytal and rectal ether. The incidence of excitement was low, there being only 4 per cent of patients requiring restraint, which is about the same as the effect produced by sodium amytal and rectal ether, where there was 5 per cent of restlessness.

It is evident that the use of the barbiturates with rectal ether causes little restlessness but that the amnesia is not all that is desired. It is apparently necessary to employ scopolamine to obtain a high percentage of success in producing loss of memory of labor.

#### PENTOBARBITAL AND PARALDEHYDE

The final group of patients were given pentobarbital and paraldehyde at the suggestion

of H. H. Rosenfield who has had considerable experience with this type of analgesia. One hundred patients were included in this series. Our results were less satisfactory than those of Rosenfield, since we found the incidence of complete amnesia to be 64 per cent. Twenty per cent had partial amnesia, while there were 16 per cent of failures. Fifty per cent of the babies breathed immediately at birth. The incidence of excitement was the highest in our series, since 24 per cent had to be restrained. We therefore feel that in our hands this combination of drugs has not been sufficiently successful to warrant its continued use.

#### GENERAL OBSERVATIONS

The effect of the different drugs was studied upon the pulse rate, the frequency of respirations, the systolic blood pressure, the total length of labor, the time interval between the first medication and delivery, the operative incidence, and the amount of blood lost during or immediately after third stage of labor.

**Pulse rate.** Observations on the pulse rate were made on entrance, one hour after the first medication, one hour before delivery, and one hour after delivery (Table II).

**One hour after the first medication.** Sixty seven per cent of all groups showed no significant variations in the pulse rate, since the pulse either remained the same or rose or fell less than ten beats. The greatest variation from the normal was shown by pentobarbital and paraldehyde since in 30 per cent of cases the pulse rose over 10 beats.

TABLE II.—PULSE

		Pentapren and scopolamine	Pentapren and racial ether	Paracetamol	Sodium amytal and scopolamine	Pentobarbital and scopolamine	Sodium amytal and racial ether	Pentobarbital and racial ether	Pentobarbital and paraldehyde
1 hour after medication	No change	9	20	30	9.4	17	18	13	3
	Rate — 5	26	15		34	20	3	3	23
	Rate 10—20	7	8	3	7	9	11		12
	Rate 20—30	6	3	4	3				1
	Rate 30—40				5	4			4
	Rate 40+				6				5
	Fall — 10	23	31	17	26		26	3	20
	Fall 10—5	4	7	6	3	7	3	6	
	Fall 5—0	6			5	4		5	
	Fall 0—30	3		3	3	4	6		
1 hour before delivery	No change	7	30	16	9.4		6		1
	Rate —	26	37		36	20	17	20	3
	Rate 10—20	6	7	12		26	20	3	6
	Rate 20—30	6	7		4	9	6	7	3
	Rate 30—40		3		3		1	3	4
	Rate 40+			3	3			3	3
	Fall —	6	7	26	3.4	3		12	
	Fall 20—15	6	7		7.3	6		4	
	Fall 15—10	4		5	1.4	4	4	7	
	Fall 10—5	4		3	5	4		3	
1 hour after delivery	No change	6	6	2	2	5		5	1
	Rate — 10	6	20		20	3	29		
	Rate — 20	5	17	7	8	3	18	6	20
	Rate 20—30	3	6		8.7	2	7	7	6
	Rate 30—40	3			3.3		3		3
	Rate 40+		5		3.7		3	5	
	Fall — 10	26	27	5	20.5	20	20	6	5
	Fall 10—5	7	6	7	10	4	5	5	12
	Fall 5—0	4			4	9	4	9	4
	Fall 0—30	6	3	6	6.4	6	4	4	
	Fall 30—40	6		3	1.9		4	4	4
	Fall 40+				4.7			3	4

3 *One hour before delivery* In 53 per cent of all cases there was no significant variation. Thirty nine per cent of the patients who received pentobarbital and scopolamine and 36 per cent of those receiving sodium amytal

and scopolamine and pentobarbital and paraldehyde exhibited a rise in pulse rate of above 10 per minute.

3 *One hour after delivery* Forty nine per cent of all groups showed no significant

TABLE III—RESPIRATIONS

		Pantopon and scopolamine	Pantopon and rectal ether	Pernoxon	Sodium amylal and scopolamine	Pentobarbital and scopolamine	Sodium amylal and rectal ether	Pentobarbital and rectal ether	Pentobarbital and paraldehyde
1 hour after medication	No change	55	57	66	53	61	71	66	44
	Fell — 5	3	16	16	15	19	13	16	17
	Fell 5-10	8		0	4	0		0	4
	Fell 0+		0	0	0	0	0	0	0
	Rose — 5	20	7	15	7	19	16	8	28
	Rose 5-10	0	0	3	2		0	0	6
	Rose 10-15	0	0	0	0	0	0	0	1
	Rose 15+	0	0	0	0	0	0	0	0
1 hour before delivery	No change	32	44	29	35	27	31	21	47
	Fell — 5	14	7	8	7.6	10	11	5	17
	Fell 5-10	1	2	0	0	0	1	0	1
	Fell 10+	0	0	0	0	0	0	0	0
	Rose — 5	47	48	45	47.5	56	55	6	27
	Rose 5-10	8	1	4	8.7	7	8	7	5
	Rose 10-15	1	0	0	0.6	0	0	1	4
	Rose 15+	0	0		0.6	0	0	0	1
1 hour after delivery	No change	47	58	50	56.5	56	45	51	30
	Fell — 5	25	27	25	20	22	18	20	16
	Fell 5-10	1	3	2	0.6	3	1	0	7
	Fell 10+	1	0	0	0	0	0	0	6
	Rose — 5	20	30	20	18	19	30	4	20
	Rose 5-10	5	2	3	3.7	0		5	
	Rose 10-15	0	0	0		0	1		0
	Rose 15+	0	0	0	1.2	0	0	0	0

changes. Thirty per cent of the patients receiving pernoxon and 29 per cent of those receiving pentobarbital and scopolamine exhibited a rise in pulse of over 10 beats. However, 0.26 per cent of those receiving pernoxon and 34 per cent of those to whom pentobarbital and paraldehyde was administered showed a fall in pulse rate of over 10 beats per minute.

The study of pulse variation reveals no drug or combination of drugs that produced any consistent effect.

*Respirations.* Similar observations upon the respiratory rate are noted in Table III.

1 *One hour after the first medication.* Fifty nine per cent of the patients in all eight groups showed no change in their respirations, while in 17 per cent the respirations fell less than 5 and in 21 per cent increased

less than 5 per minute. In 97 per cent therefore there were no significant variations from the normal.

2 *One hour before delivery.* Thirty five per cent of all patients exhibited no change. In 10 per cent there was a drop of less than 6 and in 48.5 per cent an increase of less than 5. Ninety three and five tenths per cent showed practically no change from normal.

3 *One hour after delivery.* Forty seven per cent revealed no variation from the previous observation, in 24 per cent the fall was less than 5 and in 22.6 per cent the rise was less than 5. In 93.6 per cent there was no change worthy of note.

The drugs employed exerted little effect upon the respiratory rate, nor did any particular drug or combination of drugs, have any characteristic influence.



TABLE IV—SYSTOLIC BLOOD PRESSURE

		Pantopon and scopolamine	Pantopon and rectal ether	Pernoclon	Sodium amylal and scopolamine	Pentobarbital and scopolamine	Sodium amylal and rectal ether	Pentobarbital and rectal ether	Pentobarbital and paraldehyde
1 hour after first medication	No change	4		8	10	5	7	9	18
	Fell —10	30	17	17	15	11	5	11	26
	Fell 10—20	5	7		11.5	4	3		16
	Fell 20+	1	6	10	16	6		14	10
	Rose —10	20	30	13	16	20	20		18
	Rose 0—10	3	5	10	9	3	4	7	6
	Rose 20+	7			15			3	6
1 hour before delivery	No change	17	7	6	10		10	6	11
	Fell —10	10	24	5	14	20	15	20	10
	Fell 10—20		3	5	3	5	5	5	8
	Fell 20+	6	5		9	20	7	10	4
	Rose —	15	30		17	26	26	24	27
	Rose 1—20	1	16		6	3	6		9
	Rose 20+	5	5		5	3	1	3	10
1 hour after delivery	No change	5	7	6	0	5	4	6	18
	Fell —10	20	17	11	1	15	26	5	17
	Fell 10—20	20			7	20	15	21	7
	Fell 20—30	5	6	16	9	17	5		7
	Fell 30—40			4	9		5	9	
	Rose —	30		3	14	3	10	5	
	Rose 10—20	7		4	7.5	4	1	6	7
	Rose 20+				4.4				6

*Systolic blood pressure 1 One hour after the first medication* Twelve and nine-tenths per cent showed no change, 29 per cent fell less than 10 millimeters, and 24 per cent rose less than 10 millimeters, so that in 65.9 per cent there was no noteworthy alteration.

*2 One hour before delivery* Eleven and four tenths per cent showed no changes, 26.8 per cent fell less than 10 millimeters, and 26 per cent rose less than 10 millimeters. In 64.2 per cent there was no significant change.

*3 One hour after delivery* Nine and three-tenths per cent showed no changes, 25 per cent fell less than 10 millimeters, and 13.6 per cent rose less than 10 millimeters. In 47.9 per cent there was no important alteration.

Of the patients receiving pernocton the blood pressure fell 20 millimeters in 10 per cent 1 hour after its first medication, 10 per cent 1 hour before delivery and 21 per cent

1 hour after delivery. Of those receiving pentobarbital and rectal ether 10 per cent exhibited a like fall 1 hour after receiving their first medication, 29 per cent 1 hour before delivery and 14 per cent 1 hour after delivery. These two groups showed the highest percentages of fall in blood pressure. In no instances were there significant elevations of blood pressure, thus indicating that an elevation of an existing hypertension, as in pre-eclamptic toxemia, would be unlikely.

*Total length of labor* The average duration of labor for both primiparae and multiparae is shown in Table V. Aside from a prolongation of labor in primiparae, as already noted, delivered under pantopon and scopolamine, labor was not prolonged either in the entire series or in any particular group.

*Interval between the first medication and delivery* (Table VI) No significant variation

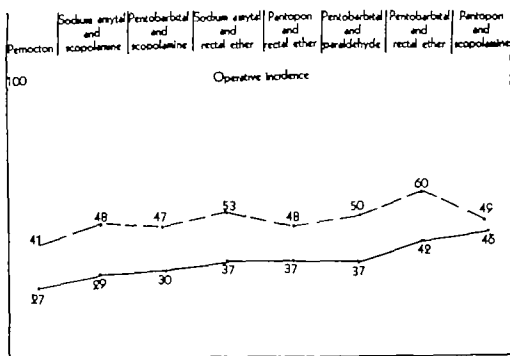


Chart 4. Operative Incidence. Percentage of operative incidence— percentage of primiparae — — —

is here noted, except in the case of pernocton, which, owing to its transient effect, was necessarily given late, and with pantopon and scopolamine in primiparae, where the average interval was prolonged

**Operative incidence** The average operative incidence was 35.6 per cent, as compared with 44.6 per cent in 1920 when no hypnotic drugs were used.

Chart 4 indicates that pentobarbital and scopolamine and sodium amytal and scopolamine show low operative incidences and pantopon and scopolamine a high incidence, especially when compared with the percentages of primiparae in each series

**Blood loss** The percentage of patients in each group losing over 300 cubic centimeters of blood is indicated in Table VII. The greatest blood loss was noted in the pantopon and scopolamine and pantopon and rectal ether group

#### SUMMARY

1 The effect of eight hypnotic drugs or combination of drugs is reported. Eight hundred and sixty unselected patients were studied. They were divided into seven groups of 100 each, and one group in which sodium amytal and scopolamine was used, of 160 patients

TABLE V—AVERAGE LENGTH OF LABOR\*

PRIMIPARAE	Hours	Minutes
Pantopon and scopolamine	3	46
Pantopon and rectal ether	17	46
Pernoxon	4	27
Sodium amytal and scopolamine	14	42
Pentobarbital and scopolamine	14	6
Sodium amytal and rectal ether	6	15
Pentobarbital and rectal ether	10	6
Pentobarbital and paraldehyde	17	13
MULTIPARAE		
Pantopon and scopolamine	13	24
Pantopon and rectal ether		26
Pernoxon	8	23
Sodium amytal and scopolamine	13	43
Pentobarbital and scopolamine	9	37
Sodium amytal and rectal ether	1	12
Pentobarbital and rectal ether	13	15
Pentobarbital and paraldehyde	0	8

\*The average length of labor was definitely prolonged in primiparae delivered under pantopon and scopolamine

TABLE VI.—AVERAGE INTERVAL BETWEEN FIRST MEDICATION AND DELIVERY\*

PRIMIPARAE	Hours	Minutes
Pantopon and scopolamine	10	8
Pantopon and rectal ether	8	30
Pernoxon	4	40
Sodium amytal and scopolamine	7	27
Pentobarbital and scopolamine	0	40
Sodium amytal and rectal ether	7	40
Pentobarbital and rectal ether	9	43
Pentobarbital and paraldehyde	8	32
MULTIPARAE		
Pantopon and scopolamine	3	18
Pantopon and rectal ether	4	46
Pernoxon	2	22
Sodium amytal and scopolamine	6	33
Pentobarbital and scopolamine	3	47
Sodium amytal and rectal ether	4	40
Pentobarbital and rectal ether	5	23
Pentobarbital and paraldehyde	4	23

\*The average interval between the first medication and delivery was definitely prolonged in patients delivered under pantopon and scopolamine

Comparative ratings according to

Anesthesia \_\_\_\_\_ Lack of effect on infants \_\_\_\_\_

Freedom from excitement \_\_\_\_\_

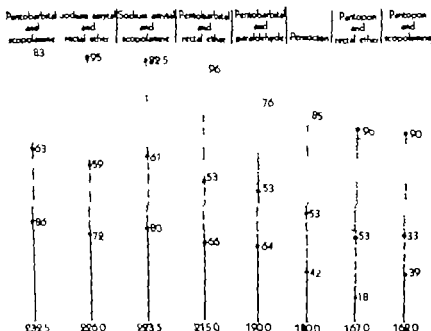


Chart 5 Comparative ratings of the various hypnotic drugs.

2. Pantopon and scopolamine in combination proved not to be satisfactory hypnotics, since only 34 per cent of patients had no memory of their labor. Only 33 per cent of the infants born to mothers who had received these drugs breathed immediately after birth. There was also a prolongation of labor in primiparae; the operative incidence was high and the incidence of blood lost was the highest encountered in the study, being 25 per cent.

3. With pantopon and rectal ether there was only 18 per cent of complete amnesia, the lowest in the series. Sixteen per cent of the

patients lost over 300 cubic centimeters of blood, the second highest in the study. There was, however, a low incidence of excitement.

4. Pernoxon is evanescent in its action and cannot be given until the end of the first stage of labor. It produces a low incidence of amnesia and considerable excitement.

5. Sodium amytal and scopolamine resulted in complete amnesia in 80 per cent of cases. No marked effect in delaying the initial respiration of the infants was noticed. There was, however, a fairly high incidence of restlessness, and the return to consciousness was prolonged.

6. Pentobarbital and scopolamine produced 86 per cent of complete amnesia, the highest in the study and the greatest percentage of infants 63 breathed immediately after birth. The operative incidence was low. The recovery after delivery was not lengthened. The frequency of excitement, however, was considerable, being 16.20 per cent. This is the only valid objection to the method.

TABLE VII.—BLOOD LOSS OVER 300 CUBIC CENTIMETERS\*

	Per Cent
Pentobarbital and paraldehyde	3
Pentobarbital and scopolamine	3
Pentobarbital and rectal ether	3
Pernoxon	20
Sodium amytal and scopolamine	
Sodium amytal and rectal ether	
Pantopon and rectal ether	1
Pantopon and scopolamine	1

\*The greatest blood loss was noted in patients delivered under pantopon and scopolamine.

7 With sodium amytal and rectal ether there was little restlessness, but the percentage of complete amnesia was only 72 per cent.

8 Pentobarbital and rectal ether was even less effective in producing amnesia although the absence of excitement was similar

9 Pentobarbital and paraldehyde produced a moderate incidence of complete amnesia. Twenty four per cent of the patients, however were sufficiently excited to require restraint.

10 In no case in any group was there noted an untoward effect upon mother or child.

11 The pulse respirations, or systolic blood pressure showed no characteristic variation during or immediately following labor in any group

#### CONCLUSIONS

1 Chart 5, which is a composite of Charts 1, 2 and 3, shows the combined rating of each group based on the percentages of complete amnesia, lack of effect on the infants, and freedom from excitement. According to this pentobarbital and scopolamine is the most effective of any of the methods studied. It is now the standard method used at the Boston Lying in Hospital since by its use we may expect 86 per cent of absolute loss of memory of labor, 14 per cent of incomplete amnesia and no failures. Its sole objection is the fairly high percentage of restlessness which we control by the supplementary instillation of rectal ether.

2 We do not believe that pantopon morphine, or any of its derivatives should be used during labor, as they have a marked effect in delaying the initial respirations of the infant.

3 The groups in which scopolamine or paraldehyde were used showed the highest percentage of restlessness. The best amnesia however was obtained when scopolamine was combined with the barbiturates.

4 Rectal ether in combination with pantopon or the barbiturates, is productive of little restlessness but the incidence of complete amnesia is considerably less than when scopolamine is used.

5 All methods used delayed the initial respirations of the infants to some extent since a control series of cases in which delivery was effected without any anæsthetic showed only 19 per cent of infants who did not breathe immediately at birth. Another control series of patients delivered under nitrous oxide-oxygen and ether showed that 20 per cent did not breathe immediately upon delivery. It is likely that all hypnotic drugs or anæsthetics given to the mother may delay somewhat the initial respirations of the infant. That this is not a valid objection to the use of such medication however, is shown by the low stillbirth rate in the series and the fact that each stillbirth can be accounted for by other reasons than the effect of the drugs given to the mother.

#### REFERENCE

ROSENFIELD, HAROLD H., and DAVIDOFF, REUBEN B.  
A new procedure for obstetrical analgesia. *New England J. Med.*, 1932, cccvii, 566.

CYST FORMATIONS OF THE SKULL<sup>1</sup>

JERZY CHOROSKI, M.D. WARSAW, POLAND, AND LOYAL DAVIS, M.D., F.A.C.S., CHICAGO

**E**XTRAVASATION of blood in the various layers of the scalp and skull will present different clinical and pathological aspects dependent on the location of the actual bleeding. If the effused blood is not absorbed or does not become organized the surrounding connective tissue as a rule tends to encapsulate it, thus creating a cyst formation. Due to special anatomical conditions, i.e. the peculiar structure and the circulatory system of bone which allow only a slight possibility for compensatory adaptation to circulatory disturbances bleeding into the spongiosa or corticulis of the bones of the skull is apt to produce cyst formations which result in unusual pathological and clinical pictures.

Some of these cystic conditions of the skull have been known a long time. However they are encountered not too frequently and present so many points of interest both from the clinical and pathological points of view that it seemed to us advisable to present three cases which seem to touch upon the problem. In two cases the cyst formation was found between the skull and the pericranium the third case presented a cyst cavity in the diploe of the frontal and parietal bones (Fig. 1).

## REVIEW OF LITERATURE

When the blood collects between the pericranium and the skull, the condition is termed a cephalhematoma (1). Cephalhematoma or tumor cranii sanguineus of the elder authors, consists of a subpericranial blood effusion following the rupture of some of the blood vessels which run between the pericranium and the skull, and is usually due to an injury during labor.

Evans (2) has been able to produce a cephalhematoma artificially by mechanical pressure, and by lacerating or dividing the vessels with a tenotome. He has demonstrated this by rhythmical injection of the ruptured blood vessels with a colored preparation. Naujoks (3) experimentally produced cephalhematoma

in a newborn and just dead infant by compressing and rubbing the sides of the head with a hard and blunt instrument, and then applying a vacuum pump. When the pump alone was applied under similar circumstances, only a circumscribed area of edema of the scalp the so called caput succedaneum was produced. Fissures of the bone, that is, minute linear fractures, often accompany the blood extravasation (Hamon 4 Kustner 5 De Lee, 6) and indeed are even thought by some to be the prevalent etiological factor in producing a cephalhematoma.

Such hemorrhages may occur, however irrespective of many factors which have long been considered as the cause of their production. They arise irrespective of the position of the fetus *in utero* without any relation to a head or vertex presentation and in labors in which mechanical assistance is not employed. Lastly even a difficult adaptation of the fetal head to the maternal pelvis is often absent. De Lee (6) has seen four cases of cephalhematoma after spontaneous head deliveries.

There have been many suggestions to explain the apparent absence in many cases of an obvious cause for the presence of a cephalhematoma. Bednar (7) thought to find it in the diminished pressure upon the head of the newborn after delivery. The blood vessels, entering the skull from the pericranium, become acutely filled up with blood the pressure of which tears their delicate walls. According to Evans (2) the injury producing the cephalhematoma is done during the partum but the blood is effused later inasmuch as when extra uterine life supervenes upon the antenatal, profound and important changes follow in the circulatory system in the blood pressure, and in the blood itself. The alterations in the blood pressure come on gradually and become more and more marked as the alterations of the blood circuit through the lungs and heart occur until about the third day the blood pressure begins

<sup>1</sup>From study made in the Department of Surgery Northwestern University Medical School.



Fig. 1. Location of cystic formations in cases of a, ossified cephalhematoma (Case 1) b, subpericranial blood effusion (Case 2) c, osteitis fibrosa of the frontal and parietal bones (Case 3) Diagrammatic.

to increase markedly. It is indeed on the third day after delivery that cephalhematomata most frequently occur. It rarely appears before 48 hours postpartum, although in Beck's collection (8) the earliest observed cephalhematoma was found at the time when the opening of the uterus was not larger than 3 centimeters and the latest appeared on the seventh day after delivery.

Keller (9) sees in asphyxia developing during the delivery an important factor in the production of cephalhematoma. The markedly dilated venous channels of the skull tear easily. Beside that, however, there is a change in the blood chemistry inasmuch as the blood becomes overloaded with carbon dioxide. This explains according to him the fact that the blood effusion is usually dark red in color and stays fluid for long periods of time. The last feature has been observed by Virchow (10), who found the cyst content in cases of cephalhematomata of 4 to 6 weeks duration to be always fluid and to contain relatively unchanged red blood cells.

Contrary to what is commonly thought cephalhematoma is of rather rare occurrence. Hennig (11) observed it only 230 times in 53,506 deliveries. Hofmökler (12) found it in 0.6 per cent of the 59,885 examined case reports. Beck (8), studying case records from two leading Munich maternity hospitals, found one cephalhematoma in 20,402 deliveries. The most frequent site of the effusion is the right parietal bone (Burchard, 13). This is apparently due to the fact that this region of the head is most frequently the presenting portion.

Unless infected, ruptured or associated with intracranial hemorrhage a cephalhematoma does not produce as a rule any clinical symptoms except for the tumefaction. The pericranium being particularly adherent to the bones at the line of suture, effusions

of the blood beneath the pericranium are limited and outlined by the lines of sutures. They may be single or multiple. In 102 cases Beck (8) found a single cephalhematoma in 88 cases, two subpericranial effusions in 12 infants only in one baby were there three effusions, and only in one were there more than three. In serious injuries it is possible to have beside a subpericranial effusion, an extravasation between the skull and the dura as well as a subdural and cortical hemorrhage (Cushing 14).

Depending on their size, cephalhematomata are usually absorbed in from 2 weeks to 3 months (Olshausen and Veit 15). The entire process of resorption may however be completed in 6 weeks. In rare cases according to Cushing (14), a cystic condition may result the hematoma remaining fluid in its center clotting and organization having taken place only about the periphery and in this state a swelling may persist throughout life. When absorption of the subpericranial blood effusion is delayed longer the swelling may according to Virchow (10) become surrounded by a ridge of new formed bone deposited along the elevated pericranial edge. At the same time the surface of the denuded bone also becomes the site of new bone formation. The blood effusion is slowly resorbed and when this finally occurs only a flat, uneventful exostosis marks the previous location of the cephalhematoma. This may sometimes lead to a permanent extracranial deformity. Potocki (16) describes such a case and emphasizes the point that there are only 4 analogous cases reported in the literature. Karewski (17) Olshausen and Veit (15) and Keller (9) mention briefly that bone salts are sometimes deposited in the elevated pericranium the space between the latter and the surface of the skull being filled up by a spongy bone tissue.

Lorand (18) actually reports such a case. A full term baby normal labor head presentation a few days after the delivery showed a tense, fluctuating non pulsating painless mass about the size of a goose-egg in the right parietal region. Eleven months later there was found in the same region a hard immovable, painless tumor mass covered with a freely movable normal skin. X ray examination of the head showed a normal outline of the skull in the right parietal region over which there was a thin bony shell casting only a very light shadow and walling off a semi-lunar space.

It seems however that Hatschek (19) is the only one who actually studied the histology of such a condition. The points of importance in his splendid microscopical study may be summed up briefly. In the first case a 17 day old girl with a cephal hematoma associated with a subdural hemorrhage in the region of the left frontal bone, the organization and encapsulation of the extravasated blood took place from the pericranium dura and from the denuded bone. The opened blood vessel channels of the bone were the source of the connective tissue. The greatest part of the periphery of both blood extravasations i.e. that between the skull and pericranium and the skull and the dura mater consisted of a layer of blood serum. The surrounding connective tissue tended to encapsulate only the hematoma. Organization was to be seen only where connective tissue was in close contact with fibrin and cellular elements of the blood effusions. New bone was laid down at the points of transition of the normally adherent pericranium to the elevated structure and in the dura mater over the entire surface walling off the hematoma.

In Hatschek's second case a 3 months old child presented an extracranial cephalhematoma over the left parietal bone. The elevated pericranium had been transformed into a continuous bony shell of adult cancellous bone tissue. Bone was laid down also in the connective tissue proliferating from the blood vessel channels of the denuded bone. Consequently the hematoma had been entirely walled off by a bony shell. Between the

hematoma itself and the bony shell there was a connective tissue capsule and the metaplasia of the connective tissue into the osteoid and finally into the osseous tissue could be observed. Between the outer and the inner walls of the bony cyst, numerous partially ossified connective tissue trabeculae divided the cavity into multiple smaller ones thus possibly producing an ultimate healing.

The majority of the cephalhematomata may subside under conservative protection of the tumefaction. Virchow (10) pointed out that aspiration of blood from a cephalhematoma is apt to reproduce bleeding but on the other hand, the pericranial exostosis is more pronounced in the case of conservative treatment than after evacuation of the blood. This was demonstrated by Betschler (20) who made comparative observations in cases of bilateral cephalhematomata in which the condition on one side was treated by aspiration and on the other left alone. Cushing (14) advises waiting for about 2 weeks and if then there are no signs of subsidence he incises and evacuates the clot. Potocki (21) advises puncturing the cephalhematoma if it is large and if it is absorbing slowly and then to compress the empty cavity with adhesive strips. Christopher (22) emphasizes that the "let alone" treatment is not without peril as the development of infection is likely to occur in cephalhematomata of long standing (Vaughan and Burnham 23).

Although cephalhematoma has been observed most frequently in newborn infants, there are a few reports of the occurrence of the subpericranial blood effusion in older children. Friedmann (24) observed this condition three times during the 23 years of his experience. In 2 children 2 and 4 years old, respectively a cephalhematoma had occurred without obvious reasons, being discovered accidentally during combing of the hair. In the third case, that of a boy 8 years old, there was a definite history of trauma 1 week previous to discovery of the cephalhematoma. In all these cases the hematoma was limited and outlined by the lines of sutures, being absorbed in from 8 to 14 days, leaving behind it the well characterized bony ridge. Francois (25) Stolner (26) and

Hohlfeld (27) have reported similar experiences and emphasized trauma as the etiological factor<sup>1</sup>

Von Recklinghausen (28), in describing the generalized disease of the skeleton termed by him *osteitis fibrosa*, reported that in the fibrous areas replacing the bone marrow regressive and progressive changes may take place. The first, which he related to liquefaction necrosis of the connective tissue resulting in formation of cysts occasionally multilocular, lined with smooth walls and containing a serous or thick fluid. They were observed by him chiefly in the long bones of the skeleton and only once in the skull. The progressive changes give rise to the formation of so called giant cell tumors, i.e., solid, brown tumors composed of numerous multinuclear giant cells in a spindle cell matrix containing deposits of hemosiderin.

Schmidt (29) first called attention to the evidence that a solitary bone cyst may accompany or be the result of a localized *osteitis fibrosa*. Beneke (30) discussing a case reported by Monckeberg expressed the view that bone cysts may be the result of a trauma and follow an intramedullary hemorrhage. He conceived them as analogous in origin to the apoplectic cysts of the brain.

It has been shown experimentally by Bajiardi (31), Haasler (32) and Enderlen (33) that a blood effusion into the bone marrow calls forth a reactive proliferative process. Konjetzny (34) confirmed their results and from his histological preparations could demonstrate how an intramedullary hemorrhage produces a reactive proliferative process of the bone marrow. The product of this proliferative process which can be compared to granulation tissue consists histologically of all the elements encountered in lesions known as *osteitis fibrosa*. The clinical course the radiological and the histological findings are very closely related to those of giant cell tumors. Frequently in the course of the disease one encounters formation of cysts

In turn, hemorrhage into the cysts may lead to an overgrowth of masses, resembling granulation tissue, which may enlarge and finally be recognized as a giant cell tumor. In the course of the natural life of this granulation tissue there is a stage of differentiation when fibrous tissue, osteoid and sometimes osseous tissue form after the blood clot becomes organized, and all the foreign elements have disappeared (Kolodny, 36). Lubarsch (37 b) supported this view of the so called giant cell tumors as being a "chronic resorptive process."

Felten and Stolzenberg (38), who found trauma as the etiological factor of the localized *osteitis fibrosa* in 81 per cent of the reported cases cite an instance of a bony cyst in which the initial trauma in the form of a small piece of metal destroyed the spongiosa with a resulting blood effusion. Fujii (39) believes that solitary bone cysts may be either the result of *osteitis fibrosa* or may be due directly to an intramedullary hemorrhage. Observing a bone cyst in a boy suffering from a hemophilia like condition he emphasizes the point that the fluid blood filling up the cyst cavity does not allow the organization of the blood effusion to take place and by continuous pressure upon the surrounding bone tissue produces its atrophy thus enlarging the cyst cavity. Barrie (40) has reproduced the so called giant cell tumor experimentally by embedding a piece of sterile gauze in the bone marrow and he agrees with Mallory (41) as to the origin of giant cells in these conditions.<sup>2</sup> He believes that they will be found whenever a suitable irritative agent is present. The hemorrhage is, according to him an essential part of the production of the giant cell growth.

Mallory (41) maintains that the giant cells of the so called giant cell tumors are similar to osteoclasts of normal bone and are due to the fusion of endothelial leucocytes attracted into the tumor by the presence chiefly of lime salts, fatty acids, and cholesterol crystals. They are foreign body giant cells. The very intimate relation of the giant cells to the vascular endothelium, the frequent lining of blood spaces by giant cells, and the tracing of the formation of giant cells to the proliferative vascular endothelium seems, according to Kolodny (46) to support Lubarsch' (37) view of the giant cells as abortive vascular sprouts. Johnson's (42) observations on 11 specimens of benign giant cell tumors of bone seem to show conclusively that the giant cells in these lesions arise from the endothelium of the blood capillaries. Aside from these giant cells no cells occur in these lesions which are not met with in ordinary inflammatory processes. Lubarsch (37 a), Konjetzny (34) and Stumpf (43) Frangenberg (44 b) deny the term of a blastoma of the so called giant cell tumors because of the absence of alveolarity in the rim of the cells and nuclei, predominance of the trophoblast of the cellular elements of the tumor successive differentiation of the cellular areas, absence of metastases, etc.

<sup>1</sup>Here belong, most likely, some of the cases reported in the literature under the name of *osteitis fibrosa* (Stroosmeyer 35). Under this and other terms have been reported traumatic collections of blood under the periosteum, the extracranial sac communicating with one of the dural sinuses either directly or through a venous channel. The pathology of this condition is not unique, however the same pathogenesis justifying therefore rather symptoms complex than a pathological entity.



Pommer (45) studying the cyst contents and the tissues surrounding a cyst of the humerus established direct proof of the hematoma character of some, at least of the solitary bone cysts. The results of his investigations may be summed up as follows. The pressure of hemorrhage upon the veins of the spongiosa produces a stasis of the tissue fluids, which causes the liquefaction of the blood content of many of the cysts and edema of the tissues in the immediate vicinity. The localized areas of loose fibrous tissue replacing the bone marrow in the vicinity of the cyst are effects of the congestion and irritation produced by the hemorrhage. The resorption of the surrounding bone leading to the enlargement of the cystic cavity the fibrosis of the bone marrow and new bone formation are therefore secondary results of the pressure from hemorrhage and increased transudation.<sup>2</sup>

Schuster (48) cited a case of a large bone cyst occurring at the site of trauma with hemorrhage into the bone marrow. He considers the origin of the cyst in his case as purely traumatic and gives the following differential points against a cyst formation resulting from osteitis fibrosa: the bone marrow around the cyst was found to be normal osteoclasts and giant cells were exceedingly scarce there was no new bone formation and there were no hemosiderin deposits found beside foci of fresh hemorrhages.

Pommer's (45) point of view on the pathogenesis of solitary bone cysts and osteitis fibrosa is upheld and confirmed by Konjetzny (34 b) and Looser (49 b). Osteitis fibrosa and the so called giant cell tumors on one side and the solitary or multiple bone cysts on the other are two forms of reaction of the bone tissue to one cause i.e. hemorrhage. Bleeding into the corticuli of the bone is more likely to produce a bone cyst as its ultimate

outcome, whereas pictures of an osteitis fibrosa or giant cell tumor (the last in older individuals) will be found more frequently in cases of intramedullary bleeding (Fig 3). These conditions representing broadly speaking a mechanically produced pathological symptom complex, will be found in normal bones as well as in bones already affected by various systemic diseases (Looser, 49 a Lang 50 a, b c). Very slight traumatism is frequently sufficient for the appearance of medullary hemorrhage. It is probable that fissure fractures or inflections with rupture of nutrient vessels will lead to them.<sup>3</sup>

Nissen (51) experimentally destroyed the bone marrow in animals submitted to parabiosis and produced histological pictures analogous to those of osteitis fibrosa. First, the blood effusion became encapsulated by a thick connective tissue wall then when the parabiosis was interrupted, the cavity became filled in with connective tissue which ultimately became ossified. The surrounding bone tissue showed pictures resembling those of osteitis fibrosa. He thought the reason for the cystic formation was connected with the hypocoagulability of the blood of the animals under parabiosis. Mandl (52) introduced a 1 per cent solution of sodium citrate into the bone marrow and injected it also intravenously. He has been able to produce in this way definite cyst cavities in the bone, concluding that the hypocoagulability of the blood after trauma, is the reason for cyst formation in the bone.

Geschickter and Copeland (53) consider the solitary bone cysts as a form of osteitis fibrosa. In their large collection of solitary bone cysts, 2 per cent of the cases could be shown to have a bone destructive phase due to a foreign body or abscess and in about 20 per cent of the cases, rather loosely classed as osteitis fibrosa, some primary disease such as osteomalacia, osteitis deformans, Paget, fragilitas osium or osteo-arthritis were responsible for this formation. However 78 per cent showed their rela-

<sup>2</sup>Actual chemical and microscopic examination of solitary bone cyst contents made by Pfister (46) revealed pale tan color showing an intensive fibrinous reaction with acidic and sulphuric acid. Rare erythrocytes were found in the sediment. The fluid had a very high leucocytosis content and low cell count. According to Bielschowsky (47), the fluid content of the cysts is never distinctly hemorrhagic, it is watery, thin, dark brown in color and contains neither the macroscopic blood pigment and blood cells. There may be a few blood corpuscles in the fluid sticking in the bone shell, or attached to the connective tissue lining there may be red blood stained masses which under the microscope show irregular blood clot and pictures of osseous fibrosis. Giant cells have been found in a few cases in the expanded blood clot, but more often they are found near the bone shell.

<sup>3</sup>This would explain the fact that trauma, in the usual sense of the word, is not necessarily the only etiological factor in producing a blood effusion in the bone. Intracortical or intramedullary hemorrhages might be the result of "physiological" trauma, i.e. trauma of daily life. It must be kept in mind, of course, that not necessarily all the cystic formation of the bone, or osteitis fibrosa and giant cell tumors, are the result of trauma and hemorrhage.

tionship to a preceding giant cell tumor phase. More broadly stated the average solitary bone cyst in the long bones is, according to them, a healed or healing giant cell tumor. Twenty nine early cases of bone cysts in their collection showed marked giant cell areas, and 60 cases of giant cell tumor of a series of 226 cases show a healing change toward osteitis fibrosa. They are in accord with Konjetzny (34 a), Lubarsch (37 b), and Pommer (45) in placing trauma in a primary position in the production of the bone cysts and giant cell tumors. Based however, on the embryological observations of the development of the blood supply of the long bones they attempt to explain the production of these lesions in the following way. Trauma acts on the cortex of the bone in relation to its periosteum, avulsing the latter and interrupting the blood supply of the cortical bone. Normal vascular channels are thus supplanted by a subperiosteal hematoma. Interruption of periosteal blood supply renders inactive the cortical bone and its normal healing powers are suspended. The medullary circulation in this region must take on an increased activity and by establishing new channels must work its way around the injured area to undertake the work of repair. This increased function of the medullary blood supply during the interruption of the periosteal circulation can take place only after osteoclasts have opened up the channels in bone for the budding capillaries. This increased osteoclastic activity occurs where osteoclasts are already unusually active in absorbing bone, and at the time when unossified cortical bone is undergoing necrosis. An imbalance is thus created between bone destruction by osteoclasts and new bone formation that would normally proceed from the reactive cortex were its circulation intact. This imbalance results in an unchecked hyperplasia of the osteoclasts and produces a tissue characteristic of giant cell tumor and the early phase of osteitis fibrosa or bone cysts.

Osteitis fibrosa<sup>1</sup> and bone cysts are very rarely found in the skull. In a series of 50 cases of the first condition published by



Fig. 2. Limitation of a hematoma. Blood coagulum with partly shrunken blood red corpuscles. Rudiments of hyalinized tissue septa are found in the coagulum which next is limited by an area rich in spindle and giant cells. One giant cell is seen to expand and like into the blood coagulum. Multiple, dilated blood vessels in the cellular area. Gradual, continual, differentiation of the cellular area into an acellular fibrous connective tissue, with formation of osteoid tissue and partly calcified bone lamellae. Schematic drawing after actual observation. (From Konjetzny.)

Bloodgood (47) there were none occurring in the skull. Geschickter and Copeland (53), reviewing the records of the surgical laboratory of the Johns Hopkins Hospital extending over a period of 35 years found that in the purely membranous portions of the calvarium (the frontal and parietal bones), not a single instance of these lesions has been recorded. In the 114 cases tabulated as "typical bone cysts" none was located in the skull. Indeed, they are not frequent as judged by the literature of the subject. Cases of osteitis fibrosa of the vault of the skull, more or less cystic, have been reported by Wrede (54), Frangenheim (44 a), Krogius (55), Kolbe (56), Petrow (57), Tormdorf (58), Looser (49 b), Ehrlich (59), and Palmer et al (60). Cases of this condition, but without cyst formation were recorded by Bolt (61),

<sup>1</sup>Excluding osteitis fibrosa of the upper and lower jaw, temporal fossa, and the rims of the alveolar border.

Therastappen (62) Herfahrt (63) Stenholm (64) Fraser (65) and Meyer (66) Osteitis fibrosa of the skull as a part of a more or less generalized osteitis fibrosa has been observed by Haberer (67) Kolaczek (68) Dreyer (69) Wanke (70) and others.

The age incidence is from 6 to 42 years in the reported cases. The process usually starts, however in the early teens. The frontal bone is the most frequently quoted site of involvement then follows the temporal and finally the parietal and occipital bones in equal numbers. Involvement of more than one of the bones of the vault of the skull in adjacent areas has been observed.

Trauma seems to be the most important etiological factor and is more or less closely related to the first appearance of the symptoms in the majority of cases. Petrow (57) in whose cases the blood vessels of the pericranium and of the haversian canals were found occluded by thrombi or hyaline degeneration of their walls, believes the etiological factor for the osteitis fibrosa in his cases resided in the pathological condition of the blood vessels which could have been produced by infectious, toxic, or traumatic causes. Ehrlich (59) reporting a case of osteitis fibrosa cystica of the frontal and temporal bones attempted because of the patient's history of frontal presentation at birth and the existence of the condition from early childhood to attribute the etiology to trauma sustained at birth. Palmer et al (60) observed a case of a 14 year old girl diagnosed clinically as osteitis fibrosa cystica of the occipital region resulting from a fracture of the skull at the age of 16 months. At the operation (Dr Charles H. Fraser) a large cyst was found in the diploe of the occipital bone 2.5 centimeters thick in its center projecting inward and tending to compress the brain beneath it. The dura and the pia mater beneath the cyst were markedly thickened and there were adhesions of the dura to the cyst wall. Because the patient showed evidences of hypothyroidism and hypopituitarism they expressed the opinion that it may be conjectured that there are conditioning endocrine factors in patients who develop cystic bone lesions following trauma, result-

ing in a disordered metabolism and predisposing to anomalous repair with typical cyst formation. Nonne (71) points out however that endocrine disorders are absent in the majority of reported cases not only of localized osteitis fibrosa, but also of the generalized form of this condition.

The clinical picture is that of more or less large tumefaction<sup>1</sup> the consistency of which may be bony or soft. The surface is either smooth or uneven. The tumor is painless on pressure or palpation the soft tissues of the scalp are not involved the skin is unchanged normal in color and freely movable over the tumor. Complaints, if present at all are due to compression of various cranial nerves or cerebral centers. Among the more severe neurological manifestations may be found headaches seizures of the Jacksonian type, and paresis in the extremities (Frangenheim 44 a) disturbances of vision hearing and taste, paresis of the oculomotor and facial nerves, as well as paresthesias in the distribution of the trigeminal nerve nausea and a variety of psychic symptoms (Ehrlich, 59) hemianopsia and visual hallucinations (Palmer et al, 60). As a rule, however the pathological process of the bone extends toward the outside of the skull and signs of increased intracranial pressure as well as other neurological symptoms are absent.

Corresponding to the tumefaction of bone the X ray examination shows a more or less distinctly outlined shadow composed of lighter and darker areas. The bone surrounding the lesion is thinned or sclerotic. Except for the case of Fraser (65) in which the lesion (a so called giant cell tumor) destroyed the internal table of the skull and filled in the extradural space, the two cortical tables are generally intact. The ballooned diploe extends usually outward except for the cases of Wrede (54) Boat (61) Ehrlich (59) and Palmer et al (60) in which there was also an intracranial expansion. In Petrow's (57) and Palmer's (60) cases the lesion was entirely cystic on X ray examination.

Gross pathology reveals the affected bone to be greatly thickened or thinned. It is

<sup>1</sup>Tumefaction (44 a) considers that only in cases of complicated, diffuse destruction of the bones of the skull and of those of the face should the term of hemiosteoma, even Virchow be used.

oftentimes difficult to make out the tables of the bone but when well outlined they may show a normal thickness. The diploe is filled out either with fibrous masses, yellow or brownish in color, or by a spongy bone tissue showing here and there patches of sclerosis. The fibrous areas are easy to cut through and give the tumor its soft consistency.

In some of the cases more or less distinct cyst formation was reported, described by some as a blue dome. The cyst or cysts may be about the size of a cherry to an apple, or larger. The gross pathology of the larger cysts (Petrow 57, Torndorf, 58, Palmer et al 60) is that of a bony tumor representing according to the duration of symptoms a more or less thick bony shell. A connective tissue capsule is found beneath the bony shell adhering very closely to the bone and entering its enlarged canals. Further, toward the interior is the cavity containing fluid, light red blood, serous fluid or jelly like masses. In Petrow's (57) Case 1 the capsule of the cyst consisted of dense fibrous layers with islands of round cells and many blood pigment deposits, beside areas of fresh hemorrhages. Blood vessels showed hyaline degeneration. The surrounding bone tissue presented pictures typical of an osteitis fibrosa. The cyst contents were rich in erythrocytes with only very rare leucocytes. Similar was the composition of the cyst wall in Torndorf's (58) case.

In the solid forms of osteitis fibrosa the microscope reveals new bone formation and bone destruction. According to descriptions found in the literature, fibroblasts are seen to change into osteoblasts and finally form osseous tissue although sometimes only the osteoid phase of the process is attained. Bone destruction takes place by osteolysis and by action of osteoclasts. Hematoblasts and fat cells disappear from the bone marrow and the connective tissue, which may be either fibrous or very vascular and rich in cells, fills up the channels of the bone marrow, the Haversian canals of the corticallis and the lacunae produced there by osteolysis. Round cells and plasma cells will be found frequently in this connective tissue. Here and there giant cells, resembling the osteo-



Fig. 3 Photograph of patient described in Case 1 showing the tumor mass below the posterior fontanelle and over the suboccipital ridge.

clasts, are scattered throughout it, but chiefly at the periphery of the lesion. Pathologically the process starts with bone destruction then comes to replacement of the bone marrow by the fibrous tissue which may ultimately lay down new bone. The relationship of bone production and bone destruction varies however, and it may come to a cyst formation.

The process is sometimes apt to recur. In Boit's (61) case, the condition recurred in the same region about 5 years after the first operation, presenting pathologically an identical picture. In the case reported by Dreyer (69) the process recurred twice. In spite of that the prognosis seems to be good. Gold and Schlesinger (72) emphasize that the transition of a localized form of osteitis fibrosa into the generalized has not been encountered. Boit (61) made a roentgenological examination of the entire skeleton 10 years after the condition had been diagnosed and operated upon in the skull and found it entirely normal. Two years after the second removal of the solid tumor, he could demonstrate a filling in of the bony defect by a new bone formation. In Palmer's (60) case the mental changes subsided after the removal of the cyst to a noteworthy degree and the hallucinations disappeared entirely.

The treatment of choice is the surgical removal of the pathological process by curettage in the cystic form, or resection of the

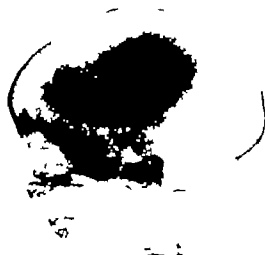


Fig. 4. Roentgenogram of skull of patient described in Case 1. Note bony shell covering the tumor mass.



Fig. 5. Roentgenogram of skull of patient described in Case 1 following operation.

invaded portion of the bone in the solid form. Good results are reported even after the most conservative surgical procedure (Krogus 55). Recurrences should be reoperated upon (Boit, 61; Dreyer 69). The large bony defects may be covered by bone transplants (Wrede 54; Frangenhelm 44 a). As a rule the post operative recovery is very good. The mortality has not been recorded.

#### REPORT OF CASES

**CASE 1:** S. R. No. 8613 (P), a male infant 7 weeks and 2 days old, was admitted to Passavant Memorial Hospital on November 29, 1931, referred by Dr. Edward L. Cornell who delivered the baby. The newborn was the first pregnancy and delivery of his 29 year old healthy mother was at full term by normal labor with an occipital presentation. It had shown a tumor mass, the size of an egg, in the occipital area since birth which was diagnosed as caput succedaneum. The mass did not seem to cause the child any discomfort and according to the mother enlarged only in the past few weeks. Physical examination showed an apparently healthy infant, presenting a tumor mass below the posterior fontanelle and over the suboccipital ridge (Fig. 5). It was about 8 to 10 centimeters in diameter and about 5 centimeters high. It was hard and firm on palpation, immovable, non-pulsating and the scalp which showed no discoloration or any inflammatory signs was freely movable over it. The mass did not seem to be tender on palpation or pressure. The anterior fontanelle was widely open; the parieto-occipital suture line was very prominent but the skull otherwise was normal. On the X ray films the skull tables appeared normal. There was no evi-

dence of a bony defect (Fig. 4). The palpable mass had a definite bony shell covering, and its contents showed little or no shadow. Neurological examination of the baby was entirely negative. Urinalysis was negative. Erythrocytes, 4,040,000. White blood cells, 9,800. Hemoglobin 78 per cent (N). Bleeding time 5½ minutes.

At the operation a semilunar incision was made through the scalp above the superior margin of the tumor mass. The scalp and pericranium were reflected downward off the mass whose surface was rather rough. Its edges became confluent with the rest of the skull in a smooth, gradual manner. A burr hole was placed in the apex of the tumor mass, and a thin egg-shell like layer of bone was broken through. The contents of the tumor appeared to consist of thick, brownish syrup-like fluid which was contained in a multilocular cystic cavity. There was a thick membrane inside the bony shell which was adherent to the inner surface of the bone. The covering of the cyst was resected away down to the level of the external table of the skull. After it had all been removed the remaining membrane which was attached to the base of the cyst or the external table of the skull detached very easily. The external table of the skull appeared then like mosaic tile work, and was thinned in two areas which would have required very little to have exposed the dura. The pericranium and scalp were sutured with black silk. The baby made an excellent postoperative recovery, being discharged from the hospital 3 days after the operation. X ray examination of the skull, made 3 weeks later showed the result of the operation to have been satisfactory; the skull was intact and the tumor consisting of the bony cyst was absent (Fig. 5).

Microscopic examination of the specimens removed at operation, i.e., the bony shell of the cyst and the capsule lining of the cyst cavity revealed the following: Sections cut through the bony piece



Fig. 6 Case 1. Osseous tissue lamellae with rows of osteoblasts surrounding them. Hematoxylin-eosin stain  $\times 85$



Fig. 7 Case 1. Blood effusion in process of organization. Hematoxylin-eosin stain  $\times 45$

show the presence of numerous osseous tissue lamellae separated one from the other by strands of loose, young connective tissue (Fig. 6). Single or double rows of osteoblasts surround the adult osseous lamellae. The more peripherally situated lamellae, stained red with eosin, show multiple foci of blue colored osseous tissue. In many places spindle-like cells of connective tissue are seen to condense and at these points a reddish stained amorphous substance is laid down. These places represent, here and there, direct prolongations of the bony lamellae. These osteoid and osseous tissue formations are in close contact with dense, fibrous, almost acellular layers of connective tissue which at rare places show a more oedematous character. Sections cut through the cyst wall tissue reveal patches of more adult fibrous connective tissue and portions where there is an abundance of young fibroblasts and capillaries energetically organizing the blood effusion which lies in the center of the cyst cavity (Fig. 7).

**Diagnosis.** Ossified cephalhematoma of the occipital region.

Roentgenologically the case resembles that reported by Lorand (18) which, however, was not operated upon and verified histologically. The complete absence of a history of an obvious trauma during the delivery or of any systemic causes which could explain the occurrence of the cephalhematoma is noteworthy. It should be pointed out, however, that the lesion was situated in the occipital region which was the leading portion of the head at delivery and that consequently a traumatic origin of the cephalhematoma in this case is most likely. Microscopically the case is similar to those studied histologically, on autopsy material, by Hatschek (19).

From specimens obtained piecemeal at the time of operation, it is difficult to reconstruct beyond doubt the actual pathogenesis of a given lesion. It may be however reasonably assumed that the sequence of events in our case was the following. Due to an injury sustained during the delivery or after, there was a rupture of blood vessels running between the pericranium and the skull with an effusion of blood between the external table of the skull and the pericranium. Encapsulation and partial organization of the blood effusion followed. It could not be demonstrated where the process of ossification of the outer layers of the hematoma actually started but the presence of blue colored inclusions of osseous tissue—which feature is accepted as sign of its primitiveness—in adult red stained bony lamellae situated more peripherally from the hematoma, points toward the pericranium as the origin of the process. This would be in accordance with the findings of Hatschek (19) who has been able to demonstrate that the very beginning of the process of ossification in his cases of cephalhematoma was in the pericranium at the points where it had been separated from the bone. The process of ossification of the cephalhematoma would start, therefore in the deep layers of the pericranium, the external layer persisting in its dense fibrous structure, as evidenced at the time of operation.

Noteworthy is the fact that the hematoma was entirely walled off on its outside surface in our case of a 7 weeks old baby. This is analogous to Hatschek's second case that of a 3 months old child. This author demonstrated however the beginning of a distinct new bone formation in a case of cephal hematoma of a 17 day old infant (Case 1).

The surface of the external table of the skull forming the base for the cephalhematoma appeared at the time of operation like mosaic tile work and was thinned in two areas. It might be conjectured that this was due either to pressure of the large hematoma or to direct disturbance of nutrition of the bone lacking its normal blood supply after separation of the pericranium over an area of about 10 centimeters. Necrotic bone changes in cases of cephalhematomata were noted by Michaelis and Paletta as quoted by Quirel (73).

As pointed out above ossification of the entire elevated pericranium in cases of cephalhematoma is of rare occurrence as is the ossification of the elevated periosteum in cases of subperiosteal hematomata elsewhere in the body. Such cases have been described by Deetz (74) as an ossified hematoma of the pelvis by Glumm (75) who reports such a condition in the tibia and by Cone (76) in the humerus. The last case presented histologically the characteristics of a so called giant cell tumor and the author states that the cases of osteitis fibrosa in his collection like those described by others, exhibit the same pathology as the ossifying hematoma, differing only in the location of and the amount of bone involvement.

CASE 2 No 128922 (W) L. M. aged 26 married, was admitted to Wesley Memorial Hospital on December 14, 1926. About 4 weeks previous to admission the patient stated that while washing her head, she noticed a slight lump over the right frontoparietal region of the scalp. This was followed in a few days by a swelling on both sides of the scalp extending from about the occipitoparietal sutures to the frontal area about 2 centimeters above the eyes anteriorly. In 4 days time the swelling spread over the right cheek, almost closing her right eye. The swelling then gradually receded in about a week, except that the lump in the scalp remained. The present tumor mass had remained practically the same for the last 4 weeks, except that it had been

somewhat smaller in size for the last 6 days because it was incised. Her local doctor told her that he obtained a little watery fluid. The generalized swelling of the head was accompanied by a dull headache, but there was no accompanying temperature and the patient says she did not feel ill. About 1 month previous to the accidental discovery of the lump over the right frontoparietal region, while moving and arranging her furniture, the patient sustained repeated injuries to her head. Other wise the past history was essentially negative. The general physical and neurological examination revealed no abnormalities whatever. The patient was fever free, the lymph nodes of the neck were not enlarged. In the right frontoparietal region of the skull there was a fluctuating mass about the size of a walnut. The mass was not pulsating and no bruit was heard over it. It was painless on palpation and pressure. Change in posture of the head coughing or straining did not cause an increase in size. The skin, showing no evidences of inflammation, moved freely over the area. Laboratory findings (urinalysis, blood count) were essentially negative. X ray films of the skull showed a defect in the external table of the skull circular in outline approximately 3 centimeters in diameter, located at the right frontoparietal suture (Fig. 8A). There was no proliferation of bone at the edges of the defect its boundaries were smooth and there was no appearance of invasion of the bone at its outer limits. The inner table was apparently intact. There were no veins running into this space. The defect had the appearance of pressure necrosis of the external table. An extra cervical vertebra was noted lying between the second and third cervical vertebrae.

Under local anesthesia, a curved incision with a scalp flap about 8 centimeters in diameter was made with the base directed anterolaterally. Immediately after the incision was made through the pericranium a small quantity of dark clotted blood escaped. By raising the pericranium further from the skull it was discovered that evidently the incision through the pericranium cut through a cyst wall, filling a depression in the external table of the skull. This depression was smooth. The cyst wall, which was thin and somewhat fragile and bloody, was removed completely from the bony floor and from the pericranium. Eroding through the external table was a large diploic vein. The bony excavation was curetted thoroughly. After complete hemostasis and closure of the wound a dressing was applied which tended to force the occipitofrontalis muscle into the bony excavation. The patient made an uneventful postoperative recovery being discharged from the hospital 9 days after operation. When seen 3 years later she was in excellent physical condition, and the X-ray examination of the skull showed a distinct filling in and regeneration of bone at the margin of the defect. The appearance suggested a marked improvement in the condition (Fig. 8B). The patient was seen last in May 1933. X ray examination of the skull did not show any

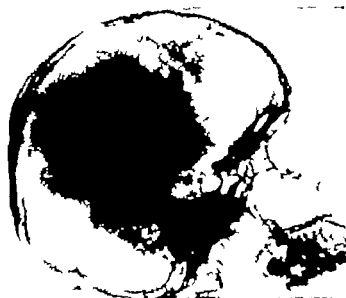


Fig 8A.



Fig 8B

Fig 8. A, Roentgenogram of skull of patient described in Case 2. Note the circular defect in the external table near the frontoparietal suture line. B, Roentgenogram of the skull taken 8 years later showing distinct regeneration of bone at the margin of the defect. C, Roentgenogram taken 7 years later showing progressive diminution in the size of the bony defect.

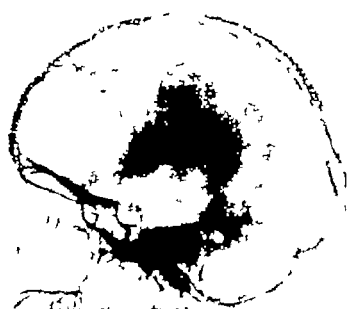


Fig. 8C.

thing pathological except for the persistence of the bony defect although of a much smaller diameter (Fig 8C). The blood Wassermann was negative blood calcium was 10.0 milligrams per 100 cubic centimeters of serum blood phosphorous 2.35 milligrams per 10 cubic centimeters of blood and the patient had no complaints whatever.

Microscopical examination of the cyst wall removed at the operation showed the membrane to consist of fibrous connective tissue with considerable amounts of red cells and large quantities of hemosiderin deposits (Fig 9) scattered throughout the stroma. This blood pigment was partly extracellular but some of it had been taken up by large compound granular corpuscles. Many lymphocytes and some plasma cells were found in the tissue both in the form of perivascular infiltration (Fig 10) and of loose infiltration of the connective tissue stroma. No polymorphonuclear leucocytes were seen. The tissue was not abnormally vascular. No endothelial lined cavities were seen in the sections and the cyst wall margins were without any definite lining membrane. There were no tubercle formations, and no dermoid and parasitic structures were seen.

Diagnosis. Encapsulated cephalhematoma complicated by a secondary infection.

The clinical and pathological picture of this case may appear somewhat obscure. Summing up the salient points of the case one sees that there is a definite history of trauma preceding the accidental disclosure of a 'lump' in the right frontoparietal region.

The disclosure of this lesion was followed a few days afterward by a massive swelling of the scalp on both sides which reached even the right cheek. The appearance of the massive swelling which receded in 1 week was unaccompanied by a rise of temperature or any other serious systemic reaction, except for a dull headache. Previous to admission of the patient to the hospital, the 'lump' was incised and it was found at that time to contain a small amount of watery fluid. At the operation a cyst was encountered, located between the skull and pericranium containing masses of dark clotted blood. Micro-



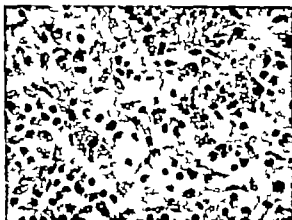


Fig. 9. Case 2. Hemosiderin deposits in an area of lymphocytic infiltration. Hematoxylin-eosin stain,  $\times 700$ .

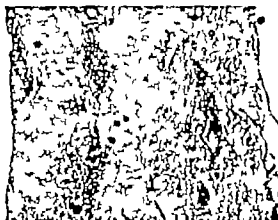


Fig. 10. Case 2. The general structure of the cyst wall. Perivascular infiltration. Hematoxylin-eosin stain,  $\times 700$ .

scopical examination of the cyst wall showed the presence of fibrous connective tissue with a considerable amount of hemosiderin deposits scattered throughout the whole of the stroma. There was also an infiltration of the tissue by round cells and plasma cells polymorphonuclear leucocytes being absent. The external table of the skull underlying the cyst was found excavated.

The pathological condition in this case could be assumed as having had the following development. Small but repeated traumas to the head produced a blood effusion between the skull and pericranium. This extravasation became encapsulated in a connective tissue wall, as evidenced by the presence in it of large quantities of blood pigment deposits. Following the disclosure of the lesion by the patient a mild inflammation of some of the loose layers of the scalp occurred—most likely of the subaponeurotic space—which, subsiding clinically, left behind it its histological manifestation in the form of the above mentioned round cell and plasma cell infiltration. We have been unable to demonstrate the nature of this inflammatory process, superimposed on the hematoma formation but we feel rather sure that based on the patient's history, physical and neurological as well as laboratory findings one can exclude such pathological conditions as syphilis, tuberculosis, or parasitic conditions.

The presence of hemosiderin deposits in the cyst wall showing no abnormal vascular

ity and no retrograde changes in its stroma, speaks against the assumption that the cyst formation and the blood pigment deposits were the results of degenerative and hemorrhagic changes in an already pre-existing pathological lesion.

The dark clotted blood masses found in the cyst cavity at the time of operation were most likely the result of the trauma of the incision into the cyst. Only a serum like fluid was obtained at that time. Indeed if the clotted blood came from the original trauma, one would be at a loss to explain why the hemorrhage was not organized instead of being encapsulated. The presence of the serous fluid in the cyst cavity on the other hand, is in accord with many observations that organization of a hematoma does not take place when connective tissue comes in contact with blood serum.

The depression in the external table of the skull underlying the cyst formation was due probably to a pressure necrosis. For this possibility and against the assumption of a primary bone lesion was its smooth surface, the absence of any pathological manifestations at its borders, distinct filling in and regeneration of bone after the cyst had been removed and the present excellent condition of the patient as well as the negative X-ray examination of her skull.

The subaponeurotic tissue of the scalp—which was in our opinion the site of the inflammatory process—is of very loose tex-

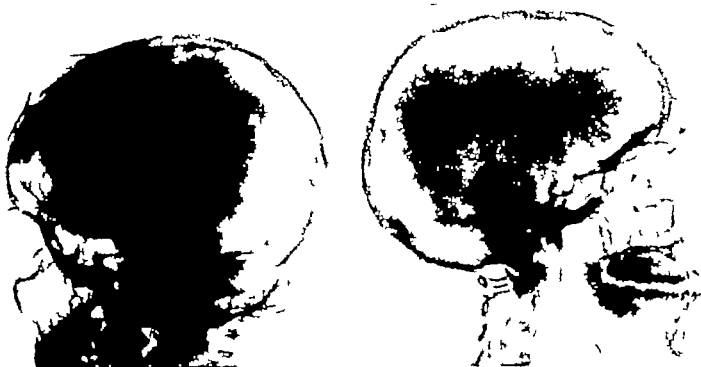


Fig. 11. Roentgenograms of skull of patient described in Case 3. Note the honeycomb appearance of the bone and separation of the external and internal tables.

ture and permits the effusion of blood or serum to spread without difficulty over a considerable area of the scalp. The limits of this spread may be posteriorly to the superior curved line of the occipital bone anteriorly to a little above the eyebrows and laterally to a level somewhat above the zygoma (Piersol 77)

Zamazal (78) Stembo (79), and Rightor (80) have reported massive swellings of the entire scalp due in their cases to a sub-aponeurotic blood effusion. It is noteworthy that the effused blood may stay in this fluid condition for longer periods of time. Rightor (80) reports the case of a boy 10 years of age who developed a swelling of the entire scalp 1 week after a head injury. Aspiration of the fluctuating painless mass removed a quart of fresh blood. Three weeks after the injury a pint of blood was aspirated and 1 week later still 4 ounces of fluid blood were drawn off.

CASE 3. No 133897 (W) T. H. aged 21 years, male was admitted to Wesley Memorial Hospital on September 5, 1927 stating that he was perfectly well until about 1919 when he accidentally discovered a lump on his forehead. No particular occurrence called his attention to the presence of this tumefaction. Since he first noticed it the mass

had been growing very slowly and steadily until it had attained after 8 years its present size. It was smooth, well circumscribed and bony in hardness. The patient complained of nothing else except the size of the mass. When 6 years of age he sustained his first head injury by striking the head on a playground apparatus. At the age of 14 he struck his head in a fall and 1 year previous to admission he sustained a severe injury to his head while diving. After the last trauma he was unconscious for a short time.

The physical and neurological examination of this well nourished and well developed young white male was essentially negative. The internal organs were found in normal condition especially there was no enlargement of the spleen and no adenopathy. Over the left frontal region and slightly lateral from the median line there was a smooth, circumscribed bony prominence. This mass was about 5.5 centimeters in diameter and about 1.5 centimeters higher than the rest of the skull. There were no areas of softness in it and nothing resembling fluctuation. It was not tender, no pulsation was present and no bruit could be heard over the mass or at its periphery. There was a very slight dilatation of a vein running laterally from this mass toward the temporal region. On X-ray examination of the skull the mass appeared to be made up of alternating areas of increased and decreased density so that it gave the appearance of being honeycombed (Fig. 11). The external table of the skull was pushed outward and it seemed that the pathological process had originated in the diploe and was ballooning the external and internal tables apart. The inner table was somewhat



Fig 12 Case 1 To demonstrate the general structure of the cyst wall. An adult bone lamella and giant cells resembling osteoclasts as seen Hematoxylin-eosin stain, X60

depressed, but not markedly so and its contour seemed smooth. All other portions of the skull well conformed to the normal anatomical features. The face, jaw and the upper cervical spine were like wise clear. There was no evidence of secondary manifestations of increased intracranial pressure. Roentgenological diagnosis was that of a bone cyst.

At the operation, under ether anesthesia a semilunar incision about the bony mass was made with the convexity of the incision toward the median line. The pericranium was separated and the skull exposed. The external table was of egg shell thick ness and had a transparent light color. Underneath the bony dome there was a thick membranous cyst containing yellow fluid. The external table was removed over the entire cyst, and the cyst wall was dissected from the bony floor. The latter consisted of multilocular cavities eroding the external and internal tables quite irregularly but not breaking through the latter. The affected bone was burred and curetted until both tables appeared normal. The pericranium and galea were sutured. The dressing was applied with pressure into the cavity so that the pericranium and galea might become attached and begin to fill it in. The patient made an excellent postoperative recovery and was discharged 5 days after operation. X-ray examination of the skull made 3 months later showed some evidence of regenerated bone at the edges of the defect. All other shadows of the cranium, face jaw and upper cervical spine were normal.

Microscopic examination of the cyst wall removed at the operation revealed the presence of dense connective tissue composed chiefly of spindle cells of uniform shape and size without any definite lining membrane. The dense stroma contained smaller cyst cavities also without definite endothelial lining and empty. In one place a violet red stained bony lamella, including bone cells was present. No osteoblasts were seen around it. Nearby but sep-

arated from it by an aggregation of round cells with heavy stained nuclei, there were about 8 to 10 giant cells (Fig 12). Their cytoplasm was opaque and contained several small, oval uniformly shaped nuclei, distinctly separated one from the other. Such giant cells also occurred in rare instances, scattered throughout the stroma but were chiefly found at the edges of the sections examined. No mitotic figures were seen. Here and there round cells and plasma cells were scattered loosely through the stroma, without any distinct perivascular infiltration. The tissue was not very vascular and hemosiderin deposits were not encountered. The general appearance of the sections examined was that of a granulation tissue with evidence of bone formation and with presence of giant cells, closely resembling osteoclasts.

#### Diagnosis Osteitis fibrosa cystica.

May 14 1933 the patient returned stating that about 6 months before he noticed a tiny bony protuberance in the mid-parietal region, a little to the left of the midline. This had gradually grown until it was about the size of a bean. General physical and neurological examination was essentially negative. Urinalysis was found negative. Bence Jones protein reaction in the urine was absent. The blood Wassermann was negative blood calcium, 9.57 milligrams per 100 cubic centimeters of blood serum blood phosphorous, 3.66 milligrams per 100 cubic centimeters of blood red blood cells, 4,300,000; white blood cells 6,500 (polymorphonuclears, 63 per cent, lymphocytes, 33 per cent, eosinophils, 3 per cent) hemoglobin, 90 per cent (T). The red cells were normal in shape no polikilocytosis no nucleated red cells blood platelets were present. The coagulation time was 2 minutes 15 seconds. In the left frontal bone, just above the hair line there was a depression in the external table of the skull about 8 centimeters in diameter representing the site of the previous lesion and operation. The base of this depression was covered with good, freely movable skin and felt bony in consistency. On X-ray examination of the skull (Fig 13) there was in the frontal region just anterior to the frontoparietal suture and to the left of the midline a depression of the inner table as well as of the external table and in this depressed skull three good sized cyst-like areas, surrounded by ten or twelve smaller cyst-like areas. They seemed to be fairly well defined. These lesions looked like typical bone cysts. Posterior to the frontoparietal suture in the midline there was another area in which there seemed to be softening of the external table, over an area at least one centimeter in diameter. X-ray examination of the entire skeleton did not reveal anything pathological.

With the diagnosis of an osteitis fibrosa cystica, the patient was re-operated upon. In the area in which the external protuberance was felt in the parietal region a slate-blue appearing projection of the skull, about the size of a bean, covered with normally appearing pericranium, was found (Fig



Fig. 13

Fig. 13 Roentgenograms of skull of patient described in Case 3 in May 1933. Note depression of internal and external tables in the frontal region. Cyst like areas of destruction are present in this area and the surrounding bone.



Fig. 13.

14A) After this bony dome was chiseled away and found to be very thinned external table of the skull a cyst was disclosed filled with bloody material. When the cyst was removed (Fig. 14B) the internal table formed the bottom of the cyst cavity and was found so excavated as to produce many very small loculi (Fig. 14C). In one of these there was a pulsation of blood, synchronous with the pulse, and one could see what appeared to be a pachyionian body in the dura mater. The cyst wall was removed completely. Small tags of pericranium were thrown into the cyst cavity and the scalp was sutured layer by layer. The wound from the previous operation was inspected and found filled with bone so that while the skull at this point was depressed there was a good, hard, firm bone in the place of the previous cavity. The patient made an uneventful post-operative recovery being discharged 4 days after the operation.

Microscopical examination of the specimens removed i.e. the cyst wall, bony dome of the cyst cavity and particles of bone curetted from the cyst cavity showed the following. The bony dome consisted of thinned but otherwise normally appearing bony lamellae. Bone cells were present and their lacunae and the Haversian canals seemed to be somewhat enlarged. There was no evidence of osteoblast or osteoclast activity. Several pieces of the cyst wall, removed piecemeal consisted of very dense fibrous tissue with scarce giant cells. There were one or two places where hemosiderin deposits were present. In some parts of the stroma groups of lymphocytes were present. Some of the portions of the cyst wall showed quite different pictures. Here the fibrous stroma was rather scarce separating

smaller or larger groups of cells. It stained pinkish red by the Van Gieson method. The cells were elongated, round or somewhat polyhedral with large centrally or eccentrically situated nuclei containing one or two distinct nucleoli and slightly granular cytoplasm. Many of these cells presented in their cytoplasm smaller or larger vacuoli. The cell borders were quite distinct and the cells were arranged, here and there in clusters or in sheets. Where they were loosely lying in the stroma one could observe that their cell bodies were drawn out into filamentous processes connecting them with other cells of similar shape or with numerous also spindle shaped cells (Fig. 15). Mitotic figures were not seen. Some of these cells fused and seemed to start to produce giant cell formation. Very few of these were observed and mostly about blood vessels. In one particular portion of the examined sections the cells were surrounded by dark stained granules or spicules. The cells were not arranged specifically around the blood vessels which were rare in the sections examined and presented a well developed endothelial lining. Wide blood spaces lined by the above described cells and filled with blood elements were not seen. Scattered between those cells were many lymphocytes and plasma cells. The particles of bone curetted from the cyst cavity contained either red bone marrow or a very young connective tissue rich in capillaries.

Diagnosis. Osteitis fibrosa cystica.

Clinically the course of the disease in this case was that of a chronic, symptomless lesion

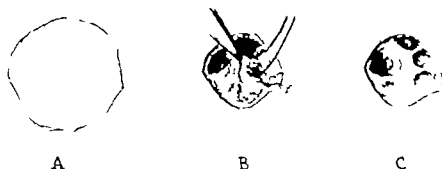


Fig 14. Case 3. Sketch made at the time of operation showing A, Bony dome covering the cyst cavity B Dissection of the capsule, C Multilocular base of the cyst cavity

of the bone typical of an osteitis fibrosa. As stated involvement of more than one of the bones of the vault of the skull in adjacent areas, has been observed. This was the case in our patient who presented two bone cysts, one just anterior to the frontoparietal suture and the other just posterior to it. Roentgenologically the lesions presented some similarity to pictures observed in cases of hemangioma of bone. In these cases however as pointed out lately by Bucy and Capp (81) the trabeculations visible on X-ray films arise in a common center and radiate out from the plane of the bone. The loculations in hemangioma in comparison with giant cell tumor or bone cyst are somewhat smaller and the cortex of the bone is not expanded as in bone cyst but is partially eroded.

Histologically the examination of the tissues removed at the operations revealed pictures characteristic of an osteitis fibrosa. As pointed out above a transformation of the bone marrow into fibrous tissue, characterizing osteitis fibrosa may be followed by regressive changes leading to bone cyst formation or by progressive changes, giving rise to a so called giant cell tumor. Cystic softening of the latter and spontaneous disappearance have several times been observed (82) so that it is not always easy to know exactly how the given bone cyst developed. This applies to our case.

Whereas the histological examination of the specimens obtained at the first operation showed generally speaking a picture of a granulation tissue with new bone formation

and evidence of bone destruction—a picture typical of bone cysts occurring in the course of an osteitis fibrosa—the microscopical structure of the tissues removed at the second operation was quite different. The most striking feature at the second operation was the presence of large groups of the above described oval round, or polyhedral cells with large mostly centrally located nuclei containing one or two distinct nucleoli slightly granular cytoplasm with distinct cell borders and drawn out filamentous cytoplasmic processes connecting most of the cells. Most of the cells contained vacuoli presence or absence of mitochondria due to the paucity of material, could not be ascertained. Clusters and sheets of these cells were separated by a distinctly fibrillary stroma, stained red with Van Gieson's method. The general morphology and arrangement lead us to consider these cells as young osteoblasts so called osteoblast reserves (Kolodny 36) ready to build up new bone.

At first glance these cellular areas of the cyst wall removed at the second operation together with the elements of the hematopoietic series might suggest a malignant bone disease. When one takes under consideration the entire clinical and roentgenological picture of the patient together with the histological findings such a possibility is rather easily excluded.

As already mentioned recurrences of osteitis fibrosa have been observed and reported (61, 69). The same is true of so called giant cell tumor. Kolodny (36) states that recurrences

seem to be unavoidable and are observed in about 20 per cent of all cases of giant cell tumors treated by a single curettage alone. According to him when a recurrence has taken place in a giant cell tumor the histology shows a variable picture and is always of an altered character.

The presence in the cellular areas as well as in the dense fibrous tissue portions of the cyst walls removed at both operations of multiple elements of the hematopoietic series, is not surprising in a lesion going on in the bone marrow or in close relation to it. In connection with this it is well to remember that the so called giant cell tumors have been termed by Nélaton *tumeurs à myéloplaxes* a term which has been changed to myeloid sarcoma and myeloma.

The true myeloma i.e., a neoplasm arising from the elements of hematopoietic series, is a very rare condition with a rapid course. It affects patients between the ages of 40 and 60 and is characterized by the multiple areas of destruction of cortical bone, protrusion beneath the periosteum and finally infiltration of the surrounding structures. Pains in the affected bone, cachexia and emaciation secondary anemia, enlargement of the spleen, hyperplasia of the regional lymph nodes, presence of the Bence Jones reaction in urine, alterations in the blood picture of the patient and metastases to internal organs are usually present in cases of myeloma whereas all these features were entirely absent in our case. The young man has had his lesion at least since 1919 the time of the accidental disclosure of his first bony prominence, and now enjoys perfect health.

A second possibility, due to the general aspect of the cellular areas in our case, is that of Ewing's sarcoma which might undergo retrograde changes and thus produce a cyst formation. This type of bone tumor is also malignant perforates the periosteum early, and metastases are observed early in the course of the disease. It is also characterized by the diffuseness of its involvement and the multiplicity of foci of origin in the same bone. Pains in the involved bone are an important and constant complaint, associated with febrile attacks throughout the course of the

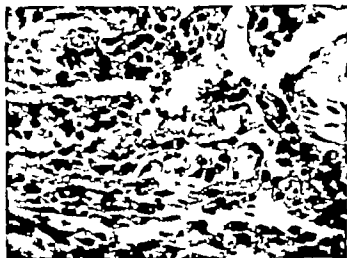


Fig. 15. Case 3. To demonstrate the general structure of the cellular area of the cyst wall. The cells are seen to lie partly in clusters, partly in sheets. The loosely lying cells are seen to be connected with each other by protoplasmic expansions. Van Gieson stain  $\times 400$ .

disease. The tumor cells are not infrequently arranged about blood vessels, no giant cells are seen and mitoses are abundant. Surgical exploration of these tumors usually leads to a continuous ulceration with a large fungus growth.

The absence of alveoli or tubules formations by the described cells as well as the lack of newly formed blood channels excludes the possibility of the presence in our case of a primary hemangioma of bone (81) or angioendothelioma described by Kolodny (36).

A direct proof that the bone cyst formations in this case were hemorrhagic in origin is lacking. It has been shown conclusively that osteitis fibrosa, being a form of reaction of the bone to various noxious agents, may be found in the presence of a foreign body infection, neoplasm, systemic disorders, circulatory disturbances (congestion) and hemorrhage. A foreign body infection, and neoplasm could be excluded in our case. Of the systemic disorders, parathyroidism has been shown to be the chief agent in producing an osteitis fibrosa (Mandl 52). The absence of a visible or palpable enlargement of the parathyroid glands and a normal blood calcium rate in our patient allow us to exclude parathyroidism as an endocrine basis underlying the lesion. Osteofibrotic changes in the bone have been shown to be the result of congestion (50 a, b). Use of the bone acts then as irritant under

this condition. This, however, applies solely to the osteofibrotic changes observed in the long bones of the skeleton.

It can be reasonably assumed, therefore that an intramedullary or intracortical hemorrhage was the origin of the cystic formations in our case. This would be in accordance with the views upheld by the majority of observers as to the origin of benign bone cysts.

BIBLIOGRAPHY

1. NAEFKE, Med. Chir. Quoted by Virchow (10) Ztschr. 819
2. EVANS, J. H. The relation of certain extra and intracranial hemorrhages in the new born. Rep. Soc. Study Dis. Child. London, 1903-1904, IV. 00.
3. NAUJOK, Ueber das Cephalhaematom. Arch. f. Gynak., 1930, cxcvi, 122
4. HAMON, J. Contribution à l'étude du cephalhematome. Thèse de doct. Paris, 1837
5. KÜSTER, O. Die Verletzungen des Kindes bei der Geburt. Stuttgart, Gehr. Krone, 850.
6. DE LEE, J. B. The Principles and Practice of Obstetrics. Philadelphia and London: W. B. Saunders Company, 1918
7. BERNAR, A. Die Krankheiten der Neugeborenen und Säuglinge vom klinischen und pathologisch-anatomischen Standpunkte. Vol. II, p. 174. Wien, C. Gerold, 850-853
8. BECK, F. Ätiologie und Therapie des Cephalhematoma neonatorum. Samml. Abhandl. d. Frauenheilk., 1904, VI, 6
9. KELLER, C. Die Krankheiten des Neugeborenen in den ersten Lebensjahren. Deutsche Klin. 1905 VII, 66
10. VIRCHOW, R. Die Krankhaften Geschwülste. Vol. 1, p. 30. Berlin, August Hirschwald, 1863
- HEIMHO, C. Die Kopfblutgeschwulst in C. Gerhart's Lehrbuch der Kinderkrankheiten. Vol. 1, p. 49. Tübingen, H. Laupp, 1877
11. HOFMEIER, Ueber das Cephalhaematom bei Neugeborenen und neber drei diesbezügliche Beobachtungen bei ein- und mehrjährigern Kindern. Arch. f. Kinderheilk., 880, 1, 305
12. BURCHARD, J. A. De tumore crani recens neonatorum sanguineo symbolae (Op. gratul.) Vratislaviae, 1837 p. 12.
13. COHEN, H. Keen's Surgery. Vol. III, p. 92. Philadelphia and London: W. B. Saunders Company, 1914.
14. OLENAUER, R. and VERT, J. Lehrbuch der Geburtshilfe. 5th ed. Bonn, F. Cohen, 1902.
15. POTOCKI, Cephalhematome ossifié chez un enfant de quatre mois. Ann. de gynéc. et d'obst., 1918-1919, xiii, (3-4 ser) 750.
16. KÄRSTNER, F. Die chirurgischen Krankheiten des Kindesalters. Stuttgart, Ferdinand Enke, 1894.
17. LORAND, L. Beitrag zur Kenntnis des Cephalhematoma externum. Monatsschr. f. Kinderheilk., 1907, V, 19.
18. HATSCHEK, O. Zur Histologie des Cephalhematoma. Beitr. z. path. Anat. u. z. allg. Path., 1930, lxxviii, 268.
19. BERNHARDT, J. W. Klin. Beitr. z. Gynec., 1862, I, 120. Quoted by Virchow (10)

20. POTOCKI, A propos du cephalhematome. Bull. Acad. d. méd., Par., 1930, xiv-xvii, 325
21. CHRISTOPHER, F. Minor Surgery. 2d ed. p. 212. Philadelphia and London: W. B. Saunders Company, 1912
22. VAUGHAN, J. C., and BURDEMAN, A. C. Minor Surgery. p. 1140. Philadelphia, Lea & Febiger, 1921.
23. FRIEDMANN, H. Cephalhematoma acutere Kinder. Deutsche Med. Wchnschr., 1904, II, No. 9, 387
24. Cephalhematoma bei acuteren Kindern. Deutsche med. Wchnschr., 40 Jahrg. 1914, 21, 573.
25. FRANÇOIS, N. Observations de cephalhematomas tardifs. Clinique, Brux., 1900, xiv, 273.
26. STOLCKNER, Discussion. Deutsche med. Wchnschr. 1914, 21, 573.
27. HOWELFIELD, Discussion. Deutsche med. Wchnschr., 1914, 21, 573
28. RECKLINGHAUSEN, F. von. Die fibrose oder deformierende Ostitis, die Osteomalacie und die osteoplastische Carcinome in ihren gegenwärtigen Beziehungen. Festachr. d. Anstalten f. R. Virchow Berlin, G. Reiner, 1891.
29. SCHMIDT, M. B. Allgemeine Pathologie und pathologische Anatomie der Knochen. Ergebn. d. allg. Path. 803, v. 805.
30. BEHNE, E. Discussion of the case reported by Moenckeburg. Ueber Cystenbildung bei Ostitis fibrosa. Verhandl. d. deutsch. path. Gesellsch. 1904, VII, 240.
31. BAJARD, Ueber die Neubildung von Knochenmark in der Markhöhle und innerhalb der Epiphysen und neber die Regeneration des Knochenmarkes in den Röhrenknochen. Untersuch. z. Naturlehre d. Menschen u. Thiere, Moenchovitz, 1838, xlii, 1.
32. HAASLER, F. Ueber die Regeneration des zerstörten Knochenmarkes und ihre Beeinflussung durch odorform. Arch. f. klin. Chir. 1893, I, 75.
33. EMBELER, Histologische Untersuchungen bei experimentell erzeugter Osteomyelitis. Deutsch. Ztschr. f. Chir., 1899, III, 293, 507
34. KOPPELBERG, G. E. a. Ein Beitrag zur Frage der lokalen tumorbildenden Ostitis fibrosa. Beitr. z. klin. Chir., 1910, lxxviii, 811 b. Die sogenannte lokalisierte Ostitis fibrosa. Arch. f. klin. Chir. 1912, cxli, 567
35. STROGEMER, L. Ueber Sinus pericranii. Deutsche Klinik., 850, No. 15.
36. KLOSTER, A. Bone Sarcoma. Surg. Gynec. & Obst., 1917, xlvii, 126.
37. LUBARCH, Quoted by K. Gangele. a. Zur Frage der Knochenzysten und der Ostitis fibrosa von R. K. Hinghausen's. Arch. f. klin. Chir., 1907, lxxviii, 953 b. Die Bedeutung des Traumas zur Entstehung und Wachstum krankhafter Gewebe. Med. Klin., 1912, I, 631
38. FELDNER, R., and STOLCKNER, F. Traumatische ossifizierte Knochenzysten. Ztschr. f. orth. Chir. 1912, xxx, 430.
39. FUJII, Zur Kenntnis der Pathogenese der ossifizierten Knochenzyste. Deutsch. Ztschr. f. Chir. 1917, cxlii, 1.
40. BARNES, G. Fibrocystic and cystic lesions in bone. Ann. Surg. 1918, lxxvii, 154.
41. MALLORY, F. B. The Principles of Pathologic Histology. Philadelphia and London: W. B. Saunders Company, 1918.
42. JOHNSON, W. W. The giant cells of benign giant cell tumors. Arch. Path. 1930, x, 197
43. STUMPF, R. Ueber die isoliert auftretende cystische und cystisch-fibrose Umwandlung einzelner

- Knochenabschnitte. Deutsch. Ztschr. f. Chir. 1912 cxlv 417.
44. FRANKENHEIM, P. a. Die Ostitis fibrosa des Schädels. Beitr. z. klin. Chir. 1914, xc, 117. b. Ostitis deformans Paget und Ostitis fibrosa v. Recklinghausen. Ergebn. d. Chir. u. Orthop. 1921 xlv, 1.
  45. POWERS, G. Zur Kenntnis der progressiven Haematomen und Phlegmasieveränderungen der Röhrenknochen auf Grund der mikroskopischen Befunde in neuem Knochenzystenfalle H. v. Haberer. Arch. f. Orthop., 1919 xvii, 17.
  46. PREUTER, C. Ueber die Ostitis fibrosa und die Genese und Therapie der Knochenzysten. Beitr. z. klin. Chir. 1907 lli, 473.
  47. BLOOMGOOD, J. C. Benign bone cysts, ostitis fibrosa, giant cell sarcoma and bone aneurism of the long pipe bones. Ann. Surg. 1919, lli, 145.
  48. SCHUSTER, D. Zur Pathogenese der Knochenzysten. Beitr. z. klin. Chir., 1921 cxviii, 191.
  49. LOOKER, E. a. Ueber die Knochenveränderungen beim Skorbut und bei der Barlowischen Krankheit (Säuglings-Skorbut). Jahrb. f. Kinderh., 1905 lxi, 743. b. Ueber die Zysten und braunen Tumoren der Knochen. Deutsch. Ztschr. f. Chir., 1925, cxlxxx 113.
  50. LANG, F. J. A. Ueber die genetischen Beziehungen zwischen Osteomalacie-Rachitis und Ostitis fibrosa. Arch. f. path. Anat. 1925 cxlvii 504. b. Ostitis fibrosa in ihren genetischen Beziehungen zur Osteomalacie und Rachitis. Beitr. z. path. Anat. u. z. allg. Path., 1931 lxxxvii, 142. c. Ostitis fibrosa. Am. J. Path., 1932 vii, 863.
  51. NISSEN, R. Ueber fibrosen Knochenmarkersatz. (Unter Benützung des Parabolversuches.) Deutsch. Ztschr. f. Chir., 1915, cxi 197.
  52. MAHML, F. Klinisches und Experimentelles zur Frage der lokalisierten und generalisierten Ostitis fibrosa. Arch. f. klin. Chir. 1926, cxliii, 1 245.
  53. GEMCHICKER, C. F., and COVELAND, M. M. Tumors of bone. Am. J. Cancer 1931.
  54. WIEDEM, Zwei Fälle von Ostitis fibrosa cystica am Schädel. Zentralbl. f. Chir., 1908 No 47 1400.
  55. KROGUS, A. Quoted by Frangenheim (44 a) Ostitis fibrosa of the frontal bone and of the contiguous bones. Finska läk.-sällsk. handl., 1913, ii, 307.
  56. KOLAR, V. Ueber Ostitis fibrosa cystica im Schädel. Inaugural Dissertation Breslau, 1918.
  57. PETROW, N. N. Zur fibrosen Ostitis des Schädels. Arch. f. klin. Chir., 1923 cxliii, 849.
  58. TOERNOW, W. Ueber einen Fall von Ostitis fibrosa cystica circumscripta am Schädel. Ztschr. f. Hals, Nasen u. Ohrenheilk., 1923-1924, vii 232.
  59. ERTLICH, Umschriebene Ostitis fibrosa des Schädels. Fortschr. a. d. Geb. d. Röntgenstrahlen, 1928 xxxviii, 658.
  60. PALMER, H. D. HARROW, R., and SCHWARTZ, L. A. Ostitis fibrosa cystica of the skull. Arch. Neurol. & Psych., 1932 xxvii, 45.
  61. BOTT, Ueber Leontiasis ossea und Ostitis fibrosa. Arch. f. klin. Chir., 1912 xcvi, 515.
  62. TREBSTAPFEN, Beitrag zum Krankheitsbilde der Ostitis fibrosa. München med. Wchnschr., 1913 lx, 1379.
  63. HERPARD, Ostitis fibrosa des Schädels. Deutsche med. Wchnschr., 48. Jahrg. No 30, p. 1025 1922.
  64. STENHOLM, T. Pathologisch anatomische Studien ueber die Osteodystrophia fibrosa (sogenannte Ostitis fibrosa von Recklinghausen) Upsala, 1924.
  65. FRANK, J. Benign giant-cell tumour of bone. Clin. J. 1931 lx 30.
  66. MEYER, W. Die Beteiligung des Schädels an der Ostitis fibrosa und Ostitis deformans, etc. Arch. f. Ohren, Nasen u. Kehlkopf., 1926 cxviii, 169.
  67. HARRER, H. Ein Fall von multiplen Knochentumoren. Zentralbl. f. Chir., 1904 xxxi, 1393.
  68. KOLACEK, H. Ueber Ostitis fibrosa. Beitr. z. klin. Chir., 1914, xc, 588.
  69. DREYER, L. Discussion in Berl. klin. Wchnschr. 1914 No. 5 234.
  70. WANKER, R. Die Ostitis fibrosa. Beitr. z. klin. Chir., 1926, cxviii, 664.
  71. NONNE, M. Die Ostitis fibrosa in ihren neurologischen Beziehungen. Deutsch. Ztschr. f. Nervenheilk., 1928, cv 35.
  72. GOLD, E. and SCHLEINKER, H. Die klinische Sonderstellung der Ostitis fibrosa localisata. Deutsche med. Wchnschr., 1930, lvi, 2076.
  73. QUÉREL, Du cephalomatome. J. d. méd. d. Par. 1907 xix, 55.
  74. DEETE, E. Zwei Fälle von seltenen Knochenkrankungen. Beitr. z. klin. Chir. 1900, xxvi, 120.
  75. GLIMK, P. Zur Aetiologie tumorverdächtigter Cysten der langen Röhrenknochen. Deutsch. Ztschr. f. Chir. 1905 lxxx, 476.
  76. COME, S. Ossifying hematoma. J. Bone & Joint Surg. 1928, x, 474.
  77. PIERCE, G. A. Human Anatomy Philadelphia and London W B Saunders Company 1912.
  78. ZAMAZAL, J. Ein Fall von aussergewöhnlich grossen Cephalhematom bei einem Neugeborenen. Wien. med. Wchnschr. 1898, xlviii, No 6 239.
  79. STROCK, L. Ein Fall von Cephalhaematoma subaponeuroticum. Deutsche med. Wchnschr., 1899, xxv 749.
  80. RIGGTON, H. Hematoma of the skull. J. Arkansas M. Soc., 1917 xiv 35.
  81. BUCK, P. C. and CAPP, C. S. Primary hemangioma of bone. Am. J. Roentgenol. 1930, xxiii, 1.
  82. EWING, J. Neoplastic Diseases. 3d ed. Philadelphia and London W B Saunders Company 1928.



## ACUTE APPENDICITIS IN CHILDHOOD

WITH A CRITICAL ANALYSIS OF 250 CASES<sup>1</sup>

URBAN MILES, M.D. F.A.C.S., FREDERICK FITZHERBERT BOYCE, B.S., M.D. AND ELIZABETH M. McFETRIDGE, M.A., NEW ORLEANS, LOUISIANA

APPENDICITIS wrote Lord Moynihan recently is a subject concerning which wisdom has not yet descended upon all of us and as one reads the astonishing teaching in the address that gave rise to his remarks, and what E. R. Flint terms the even more lamentable correspondence that it precipitated one is inclined to question whether wisdom has yet descended upon very many of us. Sir James Berry in Fallen Idols the address which he delivered last year as the one hundred fifty-seventh annual oration before the Medical Society of London literally turned the surgical clock back by pleading categorically and without qualification for a return of the days of delayed surgery in acute appendicitis, and the amount of damage he wrought was precisely in proportion to the greatness of his surgical reputation and the eminence of the organization before which he spoke. For weeks afterward the columns of the *Lancet* were filled with the controversy, the subject was debated at length before the Royal Society of Medicine and the Fellowship of Medicine, and the echoes still reverberate. The majority of surgeons who have participated in the discussion are perfectly willing to grant the advantages of delayed surgery in the late case of appendicitis, particularly the late case in which localization has occurred or is clearly occurring though they refuse absolutely to accept it for the early case, particularly the early case of the obstructive type so well described by Wilkie. Not everyone, however has so interpreted Berry's teaching and the medical world has beheld the amazing spectacle of at least one distinguished surgeon pleading implicitly if not explicitly that the treatment of acute appendicitis be conservative until events, i.e., perforation prove whether or not conservative treatment be practical.

Controversies of this sort are fortunately very rare today. The medical man who knows

or suspects that he is dealing with acute appendicitis may occasionally be willing to take the chances of delay but the surgeon who is willing to wait under such circumstances is becoming increasingly rare. The surgeon realizes that in such cases operation on reasonable suspicion shall be accounted to him for merit. He is willing to risk the performance of the occasional emergency operation that was not necessary and that might safely have been deferred. He is willing to risk the even more infrequent fatality that may follow unnecessary surgery. He is sustained by the conviction that the mortality and the morbidity that arise from such sources are minimal compared to the lives that are saved and the grave illness that is averted by immediate appendectomy in all reasonably suspicious cases. And he is correct in appendicitis the basis of salvation is the realization that no man knows, no matter what his skill what an hour let alone a day may bring forth and the further realization as Murphy wrote long ago that distrust of the inflamed appendix is still the only safe surgical frame of mind. Bastianelli goes even further and Bastianelli is a conservative surgeon. When physicians are discussing he says 'whether the case is appendicitis or not it is. When they are inclined to admit the possibility of appendicitis without being perfectly sure of it, it not only is, but it is about to perforate. When the diagnosis is sure, there is already perforation, with a more or less circumscribed peritonitis.'

If these things be true of appendicitis as a whole, they are even more true of appendicitis at the extremes of life. The average mortality for the acute disease is still, as it was in Murphy's day about 10 per cent it varies, naturally with the type of cases analyzed, as well as with other factors, but it is rarely in collected series of any size, much under 10 per cent. Two-thirds of that mortality however occurs below the age of 12 years and

over the age of 40 years, although not more than one-third of all cases of appendicitis occur within those age groups, and it is universally granted that the disease in those periods of life differs in many respects from the disease as it is exhibited in the period of its greatest incidence.

Our interest in the subject of acute appendicitis in children was stimulated by a recent study which we made from the records of Charity Hospital in New Orleans of acute appendicitis at the upper extreme of life and in the course of which we were impressed again with the relative rarity and the absolute severity of the disease in infancy and childhood.<sup>1</sup> In the 1,294 cases of acute appendicitis treated in the hospital during the approximately 3 year period covered by our study of the disease in patients over 40 years of age, only 250 had occurred in children, but in this group, just as in the upper age group, we found the pathology in a very high percentage of cases to be of an extremely serious type, and we found the mortality, while it did not equal the mortality in the 100 cases just referred to, to be considerably higher than the mortality for appendicitis in youth and early adult life. It occurred to us, therefore, that it might be of value to analyze these 250 cases of the disease in children, just as we had analyzed the 100 cases of the disease late in life, and to endeavor to draw from them some conclusions as to why appendicitis which occurs in the lower age group should be so actually and potentially serious.

We might state at the outset that all of these 250 cases were really acute appendicitis just as all of the 100 cases in the study just referred to were really acute appendicitis. We discarded all the cases in which the laboratory did not confirm the diagnosis unless there was unmistakable evidence that the laboratory and not the surgeon had erred. It had been our hope to compare the series we are reporting with other reported series, but it was a hope we were obliged to relinquish promptly, for the reason that exceedingly few of the other studies of the disease in children are confined to its acute manifestations. This situation, it

TABLE I—DETAILED PATHOLOGY IN RELATION TO MORTALITY—250 CASES

Pathology	Cases	Mortality
Acute and acute suppurative	67	
Acute with general peritonitis	1	
Rupture	5	2
Rupture with gangrene	26	3
Rupture with gangrene and local peritonitis	14	
Rupture with gangrene and pelvic peritonitis		
Rupture with gangrene and general peritonitis	18	6
Rupture with abscess	15	2
Rupture with local peritonitis	3	
Rupture with general peritonitis	17	5
Gangrene	60	
Gangrene with local peritonitis	3	
Gangrene with pelvic peritonitis	1	1
Gangrene with general peritonitis	5	
Abscess	1	

seems to us, is greatly to be regretted, the inclusion of chronic and acute cases of interval and emergency operations, in the same series, not only makes comparisons of similar types of pathology impossible, but also gives no fair picture of either group and simply confuses the discussion.

The outstanding consideration in acute appendicitis in children, just as it is the outstanding consideration in acute appendicitis in the upper extreme of life, is the very serious character of the pathological changes exhibited. In the series of 100 cases which we studied in adults over 40 years of age we found that in only 23 per cent was the disease of the simple acute or the acute suppurative variety in the 77 per cent remaining gangrene or rupture or abscess formation or peritonitis or a combination of these complications introduced factors which readily explain the mortality of 21 per cent. Table I, which represents the various types of pathology found in this series of 250 cases in children shows very much the same picture. In only 27 per cent a little over a quarter of the number, was the disease either of the simple variety or confined to the appendix and the wonder is not that the death rate for the series proved to be 7.6 per cent, but that it was not found to be very much higher.

These figures, however, need further analysis. In the 67 cases in which the disease was of the simple acute or the acute suppurative variety, the mortality was 0, not a single patient operated on in that stage of illness lost his life. But the mortality for the remaining 183 cases, in which the pathological changes were more extreme, was 10.4 per cent. Furthermore the mortality in those cases in

<sup>1</sup>Acute appendicitis over forty with a critical review of 100 cases. Am. J. Surg. in press.

TABLE II.—PATHOLOGY AND MORTALITY OF APPENDICITIS IN THE NEGRO—51 CASES

Pathology	Cases	Mortality
Acute and acute suppurative	8	
Rupture	10	
Rupture with gangrene	8	1
Rupture with gangrene and general peritonitis	6	
Rupture with abscess	6	
Rupture with local peritonitis	3	
Rupture with general peritonitis	3	
Gangrene	9	
Gangrene with general peritonitis		
Abscess		

which peritonitis was not a complication was only 3.2 per cent as compared with a mortality of 20.6 per cent, some six and one half times higher for the group of cases in which it was.

An analysis of the mortality from other standpoints is rather enlightening. As in most reported series, the male incidence is somewhat higher than the female, 14.8 against 10.2 but, unlike most reported series, the female mortality for some reason is higher than the male, that is, 8.8 per cent against 6.7 per cent.

Practically 80 per cent of these cases occurred in white children although the admissions at Charity Hospital are rather evenly divided between the races, the proportion over a 10 year period running something like 45 colored to 55 white. Appendicitis in the negro since he has taken on the fashions of civilization is undoubtedly increasing but the incidence at that, is still considerably less than it is in the white race. On the other hand when it does occur it is apparently a disease of graver potentialities than it is among the whites, a point which has been made by Harbin Miller and other writers on this subject, and which an analysis of this series substantiates.

In the 51 cases in the negro as will be seen in Table II only 8 cases 15.7 per cent, exhibited pathological changes of the uncomplicated variety as compared with almost 27 per cent for the whole series, while the death rate was 9.8 per cent, as compared with a mortality of just over 7 per cent for the whites. The difference as we say is in our opinion due more to the inherent gravity of the disease than to external factors. It is true, as we shall point out later that pernicious self medication has a good deal to do with the serious manifestations of the disease

TABLE III.—PATHOLOGY AND MORTALITY OF APPENDICITIS UNDER 6 YEARS OF AGE—22 CASES

Pathology	Cases	Mortality
Acute and acute suppurative		
Acute with general peritonitis.	8	
Rupture		
Rupture with gangrene	3	
Rupture with gangrene and pelvic peritonitis		
Rupture with general peritonitis		
Rupture with gangrene and general peritonitis	1	1
Gangrene		
Gangrene with general peritonitis	1	1
Abscess		

in the negroes but the lapse of time between the onset of symptoms and the application for treatment while it ranged from 10 hours to 14 days, was, taken case for case, very little greater than in the whites.

It is necessary to study these figures also from the standpoint of age groups. In the 22 children from 2 through 5 years, the duration of illness ranged from 8 hours in one case to 7 days in another only 4 in whom the duration of illness was stated being seen within the first 24 hours of their illness. This is not unexpected for very young children cannot tell their stories intelligibly if at all and the analysis of their symptoms must be largely a matter of surmise. It is likewise not surprising that only 5 cases in the group 22.7 per cent of the total number were of the simple acute or acute suppurative variety as compared with almost 27 per cent for the whole series, or that peritonitis should have been a feature in almost a third of the cases (Table III). The mortality for this age group is variously reported in the literature as from 15 to 40 per cent and the death rate in this group in our own series, which represents about 9 per cent of the total number of cases was 22.7 per cent. This compares with a mortality of 6.1 per cent for the group of children 6 years and over who represent 91 per cent of the whole series of cases studied.

Another and a most important consideration is the relation of the duration of symptoms to the type of pathological change and to the mortality. We have already commented upon this point in discussing the disease in the negro and in very young children but it is necessary to analyze it for the whole series of cases. Sixty five patients, 26 per cent of the whole group had medical attention within 4

TABLE IV—PATHOLOGY AND MORTALITY IN RELATION TO DURATION OF SYMPTOMS—  
250 CASES

Pathology	12 Hours	24 Hours	3 Days	4 Days	Over 4 days	Not stated
Acute and acute suppurative	17	18	14	7	8	3
Acute with general peritonitis			1			
Rupture		2		2	1	
Rupture with gangrene		5	1	3	2	3
Rupture with gangrene and local peritonitis		4	8	1	1	1
Rupture with gangrene and pelvic peritonitis			1	1		
Rupture with gangrene and general peritonitis	1	1	7	3	6	
Rupture with abscess	1	1	3	1	3	
Rupture with local peritonitis			1	1		1
Rupture with general peritonitis		2	1	1	8	
Gangrene	7	14	16	4	2	2
Gangrene with local peritonitis			1	1	1	
Gangrene with pelvic peritonitis						
Gangrene with general peritonitis			2			1
Abscess			2	1	2	2
Deaths	1	1	8	5	3	1

to 24 hours of the onset of their symptoms, with a mortality of 2.28 per cent. The mortality in the remaining 185 patients whose symptoms had endured from 48 hours to 14 days was 10.4 per cent, almost four times as high. Eight of the 77 patients operated on within 48 hours died, a mortality of 10.4 per cent, but 5 of the 30 operated on within 96 hours died, a mortality of 16.6 per cent. It is the old story in appendicitis of the mortality increasing proportionately with each day of neglect.

Table IV shows the relation of the various types of pathological change to the duration of symptoms, and reveals about what would be expected, a degree of pathology increasing in more or less proportion to the delay in seeking treatment. Considerations of this sort can never be reduced accurately to statistics for the reason that certain cases of appendicitis exhibit an exalted virulence from the onset, while in other instances pathological changes are occurring long before clinical evidences of them are apparent, but on the whole it may be fairly said that, other things being equal the degree of pathological change is proportionate to the length of time symptoms are evident. The cases of general peritonitis and

of abscess formation occurring within the first 12 hours may perhaps be doubted, on the grounds of inaccurate history and the practical impossibility of such extreme pathological changes coming to pass within so short a time, but that facile explanation cannot be used for the other groups, and there is evident in this table an astonishing number of instances of very serious degrees of pathological change occurring very early in the illness. More than half of the patients seen within the first 24 hours, for instance, exhibited types of appendicitis over and beyond simple inflammatory changes, as did more than three quarters of the patients who were seen within 48 hours.

While these findings correspond in large measure with our findings in the 100 cases of acute appendicitis in adults in whom less than half of the patients seen within 48 hours exhibited the simple type of disease, it is not the general rule in appendicitis, and it bears out the contention of all writers on the subject that appendicitis in children, as in old people, develops with a terrible rapidity when once it has gained a foothold. Gallie, for instance, states that something like 70 per cent of the children admitted to the Toronto Children's

Hospital enter with the appendix already ruptured.

It is unquestionably true, given the same duration of acute appendicitis in a child and in a young adult, that the former is likely to exhibit a much more serious and widespread disease than is the latter but the explanations advanced are far from satisfactory. That rupture occurs early in children there is no doubt, and perhaps it occurs, as it is generally stated, because the structures of the appendix in childhood are very delicate and because they are made up of a relatively large amount of lymphoid tissue. But the acceptance of that hypothesis introduces further difficulties. It is universally admitted that tonsillitis is as frequent as it is in childhood because of the very large amount of lymphoid tissue in the tonsils at that time of life. But if the appendix also contains a very large amount of lymphoid tissue, and if the fundamental pathology of tonsillitis and appendicitis is the same—of that there can be little doubt—why should the former disease be so prevalent and the latter disease at least relatively so unusual? Is peritonitis so frequently present, and so frequently of the diffuse or spreading or general variety whichever we may choose to call it, because of the short, transparent omentum of childhood and the weakened abdominal protection or are there other causes? Finally is the grave character of appendicitis in children with its correspondingly high mortality really due to a lower resistance in children or to something inherent in the disease? We are far from sure that it is wise to accept without reservation loose statements about the low resistance of childhood. Children frequently exhibit an amazing amount of resistance to infection and to injury and frequently recover from serious illness with a smoothness and promptness that make such an hypothesis untenable. We can offer no satisfactory replies to these questions, but we are unwilling to accept unqualifiedly the explanations that are generally advanced and accepted without question.

External factors contribute largely to the degree of pathological change found in acute appendicitis in children not the least important being the very frequent difficulty of

diagnosis. Peterson makes the statement that the differential diagnosis of the disease is really simpler in children than in adults because there are fewer conditions to eliminate, but that statement, like many others breaks down when it comes to the test. There may be fewer conditions to eliminate but their elimination is attended with very much greater difficulty. In the first place, the importance of an adequate history in the diagnosis of any disease is not a matter of debate we are among those who believe, given the choice of history or examination upon which to make the diagnosis that the history is infinitely more important. But we are dealing here with a group of patients who cannot tell their stories coherently if they can tell them at all, who must have their symptoms and the course of their disease related for them by parents and nurses who may have entirely overlooked the onset of the illness or who may misinterpret what they have seen. The powers of observation and of narration differ markedly in different individuals, even in the so called intelligent classes, and it is easy to conceive how wide are such differences in the persons treated at a public institution particularly when they are of the negro race. Time and time again we have noted in appendicitis as well as in other diseases, that the gravest illness has been discovered only after a lapse of time or when coincidental circumstances directed attention to it. Furthermore as Farr has pointed out, many children with appendicitis obscure their symptoms by their course of conduct. The average child as he says, will play as long as it is possible for him to get about, until his pain becomes really disabling, and we found, in a large number of cases in this series, that that was quite true. The child felt sick, he had some pain, he vomited, then he felt better, and he went out to play or was sent to school, sometimes for a few hours, sometimes for a day or two. A history of that sort is not unusual and it is always misleading. Why should serious illness be suspected in a child who behaves in this fashion? Yet more than one death in this series is accompanied by just such a story.

The second point of difficulty is the frequently atypical character of the disease. Ap-

pendicitis at any age is not a disease of sharply classical outlines. In the series of 239 deaths analyzed by Miller, in 1930, not more than half conformed to the supposed classic triad of symptoms, while in the 100 cases of adult appendicitis which we personally studied the percentage of atypical histories was even higher. It was not by chance that Bruce writing on the atypical symptoms of appendicitis, should have selected three of his four illustrations from childhood. We doubt the wisdom, indeed we indict the judgment of those surgeons, illustrious though they be—they include, among others, Lord Moynihan and the late John B. Murphy—who make categorical statements about the symptoms of appendicitis and especially about their chronology.

Moynihan, for instance, makes the unequalled statement that if pain be not the first symptom, appendicitis can be excluded. But can it? In 245 of these 250 cases, the histories were written in considerable detail, indeed were rather better than the average, but in only 224 cases was pain the first symptom, and there was no constancy as to where it developed. In the majority of cases, it is true, it finally localized in the right iliac fossa but it sometimes did not, it sometimes began there, it sometimes began in the epigastrium or about the umbilicus, or in the pelvis or even, in 5 cases, on the left side in which location it remained until operation. Though in many instances it developed insidiously it was usually of sudden onset, and in 22 cases which is very characteristic, it awakened the child from sleep. The point to which we would direct attention, however, is not the variable character and location of the pain but the fact that in 21 of the 245 cases about which we have complete data, it was preceded by other symptoms, by vomiting in 15, by fever in 5, and by headache in 1. That is a small percentage of the total number of cases, it is true, but it is large enough to invalidate, indeed to make very dangerous, the statements of Moynihan and others that pain is without exception the first symptom of appendicitis. It usually is, but there are enough exceptions to the rule to make the generalization both worthless and misleading.

There is much else to cloud the diagnosis of appendicitis in children besides the fact that the symptoms do not always occur in the grouping or in the sequence in which one is taught to expect them. Seven of these 245 patients, 4 of them in the group in which vomiting was the first symptom, apparently had their illness precipitated by some dietary indiscretion, the error being occasionally very indiscreet indeed. The same number of patients, by the way, in our adult group dated their illness from dietary sins and there is rarely a study of disease of the digestive tract in which a certain proportion of cases is not so ushered in. Dietary indiscretions in children are frequent enough to warrant very careful consideration and there is something to be said in defence of the physician who however mistakenly, bases his therapy on the obvious facts and gives a purgative to rid the system of the offending food.

Constipation is ordinarily supposed to be a common symptom of acute appendicitis, but in only 25 cases in this series was it very marked. Seven patients exhibited a diarrhoea, of whom 1 died. In adults the association of diarrhoea with acute appendicitis has been, in our experience a very serious sign particularly in the disease as it is manifested in middle life and beyond. That it is less serious in children we are willing to grant, though we cannot, in the face of these histories accept the statement of the occasional writer that it signifies a less severe type of illness. It always clouds the diagnosis, and it made particular difficulties in this series in 1 child who died. He was one of the patients under 5 years of age and for the preceding 6 months he had had intermittent and severe attacks of diarrhoea. His fatal attack of acute appendicitis was ushered in in the same fashion, and it is small wonder that the diagnosis was delayed. The coincidence of intestinal infestation in 9 children, of whom 2 died, is probably only coincidence.

Ten of these children complained of dysuria, and in 14 cases, not all of them included in the 10 just mentioned, the urinalysis revealed blood cells, pus, or even casts. Such findings are not unusual in acute appendicitis in childhood, Tasche, Helmholtz and Richter, among

others, mentioning them in their reports. The explanations are not entirely satisfactory. Our own opinion is that the abnormal findings are usually to be interpreted simply as manifestations of toxemia. We consider less logical such explanations as direct involvement of the kidney inflammation of the bladder by the juxtaposition of an appendiceal abscess, or the creation of a urethritis from contact with the inflamed appendix. The etiology of the complication however we are not chiefly concerned with. We introduce it merely to emphasize another difficulty of diagnosis. It should be added that 2 of these children had had in the past clearcut attacks of pyelitis, for which they had undergone hospital treatment and it was no simple matter to decide whether the present attack was another recurrence of the pyelitis or was really acute appendicitis.

Eight patients had chills, and in only 1 of this group was the disease of the simple acute type peritonitis was a feature in 4 cases. Chills in the adult particularly in the adult over 40 years are in our experience of very great significance. Such patients almost invariably exhibit at operation a degree of vascular involvement that is always very serious, such as extensive gangrene, mesenteric thrombosis, even pyelophlebitis, conditions that are frankly beyond the reach of surgery. The significance in children however in whom the vascular factor is not notable, is evidently much less for none of the cases in this series in which chills occurred terminated fatally.

Pneumonia is the disease of childhood most likely to be confused with acute appendicitis, and Adams and Berger report a typical series of 145 cases of pneumonia in patients between 2 and 15 years, in 17.5 per cent of which the diagnosis was acute appendicitis. Trousseau's advice is sound always to examine the chest of an infant who complains of abdominal pain but the differentiation is not always so simple. Pneumonia and acute appendicitis in their classic forms are totally different diseases, and even in their atypical forms they are unlike in many particulars. The child with pneumonia usually has a higher temperature, a higher leucocytosis, a different type of breathing, a characteristic movement of the alae

nae, and an appearance of being much sicker than the child with acute appendicitis. But these differences are not always apparent. The temperature, the pulse, and the respiration of the patient with appendicitis may be, as we shall point out shortly within any range. The respiration in childhood is always faster than in adult life, so an elevation must be very marked to be appreciated. The breathing in childhood is normally lower abdominal and the child with acute appendicitis in self-protection often changes his normal type of respiration to the shallow upper abdominal type characteristic of pneumonia, both consciously and unconsciously holding his lower abdominal muscles rigid to protect himself against pain. In our opinion Holland's point of differentiation is, the X-ray excepted as good as any and is certainly practical. The child with pneumonia, like the child with any other infectious disease, will sleep for more or less long stretches, while the child suffering the pain of appendiceal disease will neither sleep himself nor let any one else sleep. It must not be forgotten, too that pneumonia and acute appendicitis are not incompatible, may occur simultaneously. That was the situation in 2 cases in this series, in both of which the appendix had gone on to gangrenous changes before operation was done.

A discussion of pneumonia logically introduces a discussion of the relation between disease of the upper respiratory tract and acute appendicitis the possibility of which has been acknowledged as Gerslley points out, ever since Farsac of Bordeaux made the original observation in 1909. Tasche, Gerslley, Eliason and others have emphasized the relationship, and Brennemann who has made a special study of a certain type of abdominal pain not appendicular in origin which is associated with throat infections, has continued his study from the opposite point of view, feeling a quite natural degree of responsibility for his teaching since it clearly introduces the possibility that some cases in which acute appendicitis is the chief pathology may be overlooked. His figures are worth quoting. He found in 35 hospital cases of acute appendicitis 17 per cent with throat infections, and he found in 10 consecutive private patients,

4 with gangrenous appendices, whom he saw in consultation, 9 with definite throat infections and 1 with a possible throat infection. In our 250 cases, 92 children, more than a third of the total, either had a history of repeated attacks of tonsillitis and upper respiratory infection some immediately preceding the attack of appendicitis, or exhibited tonsils which were severely inflamed and cryptic and which must have been true foci of infection. The exact relationship between upper respiratory infections and acute appendicitis is not yet settled. It may be as some writers assert, that the respiratory disease is responsible for indigestion and consequent intestinal fermentation, but it is more likely, in our opinion, that the same infection localizes in two separate and distinct places. Again however the etiology of the complication is not so important as the realization that the coincidence is possible. A child with an acute throat infection who develops abdominal symptoms needs very careful observation to rule out appendicitis. Some unnecessary operations have been done under these circumstances but they are surely less to be regretted than the occasional disasters that have occurred because operation was not done.

The differential diagnosis, again cannot be made, as Table V shows, on the basis of temperature, pulse, or leucocytosis. Acute appendicitis can exist with any degree of temperature from below normal to 105 degrees and above, although the more moderate elevations are more usual, and a hyperpyrexia usually means appendicitis plus complications. Acute appendicitis can exist, again, with a pulse rate below 80 as well as with one above 150. The pulse is rarely rapid at the onset of the disease or even immediately after rupture has occurred, and much more important than the absolute rate are the changes which take place in it, a steady acceleration, even though slight, from hour to hour is very significant, but waiting for it, let us point out, brings about the very delay in treatment which we are seeking to prevent. Finally, acute appendicitis can exist with a leucopenia as well as with a hyperleucocytosis, with a differential count of 40 polymorphonuclear cells as well as with one of 98

TABLE V—PATHOLOGY AND MORTALITY IN RELATION TO TEMPERATURE, PULSE, AND LEUCOCYTOSIS—250 CASES

Temperature	Acute	Rupture	Gangrene	Rupture and gangrene	Abscess	Peritonitis	Deaths
to 98.6	8		4	1	1		
to 99	13		0	3	1	7	
to 100	28	1	27	4	8	11	4
to 101	12	1	0	6	10	18	5
to 102	6	1	8	8	1	13	4
to 103	1	2	1	5	6	6	4
over 103						4	2
Range—97.4 F to 107.2 F							
Pulse							
to 80	4		1				
to 100	35	1	25	3	7	10	1
to 11	7			4	1	12	1
to 20	0	1	15	10	10	8	8
to 130	7		5	6		0	4
to 14	3	2		3	6	8	4
to 150			1			4	4
over 50		1			1	3	3
Range—72 to 74							
Leucocytosis							
under 10,000	16	2	7	1		4	4
to 20,000	45		28	19	20	39	6
to 5,000	4		3	4	5	8	2
to 30,000				5	10	10	3
over 30,000						8	
Range—3,000 to 44,700							

It is quite true that a leucopenia is usually of grave import—in this series 4 of the deaths occurred in children with a white count less than 10,000 but, on the other hand 7 occurred in children with a white count over 25,000. Ochsner long ago contended that the chief value of the blood count in appendicitis was postoperative and surgeons, while they still use it faithfully as a diagnostic measure are more and more inclined to agree with him. The chief point to be noted about the temperature the pulse rate, and the total and differential blood count is that any type of pathological change may exist within any range and that they all are of differential value only in the aggregate, never independent.



ently for the individual patient for whom an individual diagnosis is being sought

Enough has been said on these various points to make it clear that the diagnosis of acute appendicitis in children is no simple matter and that the delay the not always unreasonable delay in the recognition of the disease explains at least part of the pathological condition which these patients exhibit. Another explanation is the type of treatment which is so very generally instituted and which inevitably leads, as Lord Moynihan well puts it to therapeutic peritonitis and to a subsequent therapeutic death. It is the old old story of abdominal pain and cathartics, and it crops up with ghastly regularity in every paper on the subject of acute appendicitis. In the adult series which we recently studied, 41 of the 100 patients stated that they had taken purgatives but they practically all took them on their own initiative. In these 250 cases, 88 of the children roughly one third of the series, had been given purgatives, and we do not doubt had the specific question been asked that the number would have been materially increased, for in only a small percentage of the other histories was it stated categorically that a purgative had not been administered. In 11 cases the purgatives had been repeated sometimes as many as 5 times, when the stomach with what Moynihan calls

a most proper act of rebellion, had expelled the first dose. Now note the difference in the circumstances. The adult with rare exceptions takes his own purgative, acts on his own responsibility. The child without exception has the purgative forced upon him usually by his mother or his nurse occasionally as in a few cases in this series by the medical man and he thus becomes the helpless victim of the philocathartic propensities, to quote Lord Moynihan again, which seem to be inseparable from the state of motherhood.

We can do no better than to continue to quote Lord Moynihan on this theme, for no one else has written on it with the vigor and the force that he has. For more than 20 years he says, he has not operated on a single case of perforated appendicitis in which the sequence of events has not been purgation and

perforation. Into that alliterative sequence we would interpolate another word, we would make it read purgation procrastination and then perforation. For the chief danger of purgation is the procrastination which permits the intestines to be lashed into activity which permits the appendix as Deaver says like Vesuvius to balloon with pus and finally to burst its bounds while the instigators of the evil, the persons who have administered the purgative wait to see what is going to happen. The physician says Royster when in doubt is given to leading laxatives, and that is true of the profession to some extent but it is overwhelmingly true of the parents and guardians of little children who in their well meaning ignorance adopt the very method of treatment which is most calculated to produce disaster.

Moynihan is unquestionably correct when he says, all other considerations aside, that the mere giving of a laxative is indication enough for instant operation. Eighty-eight of these children had had purgatives, and 59 of them had ruptured appendices the only reason rupture did not occur more frequently we are sure is because so many times the first dose or the repeated dose of castor oil was vomited. Eight of the 59 children with ruptured appendices died which means that 40 per cent of the total mortality of 19 occurred in this group. It might be added that 25 of the 51 colored patients had taken purgatives, and that every negro death occurred in this group. The purgatives they took exceeded both in number and in violence those in the white race and the persistence with which they dosed themselves and the medicines they used would be almost humorous if the outcome of their method of treatment had not been so tragic.

Fifty seven of these children 22.8 per cent of the total number had had previous attacks of appendicitis, but an attempted comparison with other series (Tasche and Spano Freedman and others) in which the percentage is very much higher is valueless, since the other series include, as we have already mentioned, the chronic cases also. The interesting thing in this group of patients, aside from the fact that the diagnosis was made so much more

simple by the previous history, was the type of pathological change, which was less severe than in any other group in the series. In 26 of the 57 cases, not quite half, the disease was simple acute or acute suppurative, as compared to the 67 cases in the whole series of 250, which is not quite 27 per cent. Peritonitis was a feature in only 9 cases 15.8 per cent, as compared with an incidence of 35.2 per cent for the whole series. Finally, the death rate was just 3.5 per cent as compared with a mortality for the whole series of 7.6 per cent. Again we attempt no explanations. Individuals with repeated attacks may develop a degree of immunity to the disease, or recurrences may tend to happen in persons whose natural resistance is high. We merely point out that, whatever the reason, repeated attacks of appendicitis seem to confer upon the patient at least a relative degree of security.

In 6 cases in this series there was a specific history of trauma. The attack began immediately or very soon after some sort of abdominal injury, and the sequence of events was close enough in point of time, to warrant an assumption of cause and effect. Children, we grant, are very frequently injured while playing and the argument may be a specious one and the sequence pure coincidence but that the relationship existed in these cases there can be no possible doubt, just as there can be no doubt of a similar relationship in the 6 instances reported by Speed in his series of 313 cases (Royster).

Another interesting and unusual group of cases has to do with the 4 instances of acute appendicitis associated with pelvic inflammatory disease apparently of tubal origin. Two of these patients were white, 2 colored, and the ages were respectively 4, 5, 9, and 10 years. One child had a positive gonococcal smear, in the other cases no bacteriological examination of the vaginal secretions seems to have been made. In each case the appendix was definitely diseased, in each case there was equally definite evidence of tubal involvement and speculations as to the primary cause of the pathology offer an interesting field. Pelvic inflammatory disease is most unusual in young children, indeed is denied altogether

TABLE VI—OPERATIVE PROCEDURE AND TYPE OF INCISION IN RELATION TO MORTALITY  
—250 CASES

Procedure	Cases	Deaths
Appendectomy	130	3
Appendectomy with drainage	16	3
Appendectomy with drainage and enterostomy	24	0
Drainage only	10	2
Colpotomy	1	1
Enterostomy and drainage	1	1
Incision		
McBurney*	126	13
Right rectus	25	3
Right	14	1
Midline	9	1
Colpotomy	1	1
Over scars	7	1
Not stated	4	
3 converted into Weir		

by some gynecologists, yet the case with the positive smear, if no other would seem to be a case of ascending infection. Are the 3 other cases of the same type? Or are all of them instances of tubal disease secondary to acute appendicitis the positive vaginal smear being merely a coincidence? Again we do not attempt to answer our own questions, we merely state them as problems which are open to discussion.

A word might well be said as to methods of examination in children, for abdominal examination is no simple matter. It is the part of common sense to avoid at first the point of supposed tenderness to approach the region of greatest pain only after some degree of confidence has been established. It is likewise an excellent plan to examine the child during sleep, though it is rarely possible of achievement. Of all the advice which has been given Christopher's strikes us as the soundest that a "too boisterous Polly-annaism" is heartily to be condemned, a child in the agonies of acute appendicitis has enough to bear without being further insulted by the vagaries of an adult endeavoring in this fashion to establish a rapport with him.

As to the interpretation of the abdominal findings it must be remembered that rigidity in children is frequently absent indeed almost always is absent if the appendix is retrocaecal or lies deep in the pelvis or if examination is done before a peritoneal reaction is established just as it must be remembered that the complaint of tenderness is likely to be misleading because the child in his fear of being hurt, will complain at the slightest touch. Examination by rectum is not always easy, but it is

In our opinion a very valuable diagnostic aid far more so than it is in the adult because the examining finger can reach higher and feel more. It was carried out in 53 cases in this series, with positive findings in 50 bilateral pain indicating diffuse pelvic inflammation was present in 14 cases. The procedure was equally valuable in examining a number of patients after operation in order to confirm or eliminate the presence of residual abscess.

Table VI, which sets forth the procedure in relation to the mortality needs little comment. The figures speak for themselves. Whether the 3 patients who died after simple appendectomy would have lived if another plan had been followed is beside the point: no one can decide that now. The thing to note is that in this series, just as in most reported series (Farr, Hudson, Woodall and others) in very nearly half of the cases, drainage either alone or in combination with enterostomy was considered necessary because of the type of disease which had to be dealt with. That the great majority of deaths occurred in this group of cases has, in our opinion and as we have repeatedly said in previous papers on appendicitis, nothing whatsoever to do with the wisdom or unwisdom of the procedure. The whole acrid controversy over drainage versus simple closure is futile. The wisdom of drainage after the event can be judged on just one point: the degree of pathological change to be combated and of its seriousness in this group of cases there can be no possible doubt. It is very easy, as Royster says, to play the game after it is finished and into that fallacy we decline to be led.

Carcostomy as an auxiliary procedure was done in 65 cases, something over a quarter of the total series; something over half of the number of cases in which the conditions present demanded a more radical procedure than simple appendectomy. That is a very high proportion and the wisdom of the procedure is, as we have said in previous papers on acute appendicitis, at least open to question. It is apparently routine under certain circumstances among the group of surgeons who performed the bulk of these operations, and certainly there is much to be said in its favor. It

is far more effective as a preliminary procedure than late enterostomy. It shortens the actual operating time because it eliminates closure of the bowel. It reduces postoperative distention and permits adequate intestinal drainage, and it therefore acts as a prophylactic against the development of ileus. In children as in adults, fistulae in this region tend to close spontaneously: in only 3 cases in this series did the patients leave the hospital with a discharging sinus. Moreover a criticism of the death rate in the cases in which it was done, 9 of 65, 14 per cent, is not fair for exactly the same reason that a criticism of the percentage of cases drained is not fair: only a surgeon present at all the operations could properly decide when enterostomy was justified and when it was not. On the other hand, granting all of these things, we still wonder whether it should have been performed as frequently as it was. For one thing it prolonged the convalescence in many cases quite out of proportion to the apparent clinical course: 30, 40, 50 and 75 days stay were not uncommon and one patient was in the hospital 94 days. More than 40 per cent of these 250 patients, 104, were in the hospital longer than 2 weeks and at least part of their prolonged stay must be set down at the door of surgery that was perhaps more zealous than was actually necessary.

The 18 cases in which drainage only was done (in 2 cases combined with enterostomy) undoubtedly represent a wise conservatism. The removal of the appendix, other things being equal, is greatly to be desired but is never to be recommended unless it can be done swiftly without undue prolongation of the operative procedure and anesthesia, without the soiling of uncontaminated areas of peritoneum and with a minimum of trauma. It must not be forgotten that very many of these little patients were exceedingly ill and in no condition to withstand a single extra moment of anesthesia or a single extra operative manipulation. We were repeatedly struck, as we read these charts, by the emphasis which even careless and unperceptive internes placed upon the appearance of the children: the acutely ill impression they created, the anxious, hippocratic faces that gave

eloquent evidence of the intraperitoneal damage that had been wrought

The single case in which only colpotomy was done and which terminated fatally should be particularly commented upon, though we by no means would imply that another procedure might have changed the outcome. Colpotomy is valuable as a postoperative measure for a cul-de-sac abscess, but we are very doubtful indeed as to its propriety as a primary procedure, without an abdominal incision to determine exactly what conditions are present within the peritoneal cavity

The type of incision employed in acute appendicitis depends very largely upon the personal preference of the surgeon who is doing the operation. There is something to be said for each, though the end result, in our opinion, depends far less upon how the abdomen was opened than upon what type of pathological change had occurred within it and what degree of suppuration occurred after it was closed. The McBurney incision if all goes well, permits the conduct of the whole operation within a small area shut off from the general peritoneal cavity, it reduces peritoneal soiling to an inescapable minimum, it reduces the risk of postoperative hernia and it usually permits satisfactory drainage. But all does not always go well. The most careful anatomist, the most expert surgeon, whose McBurney incision is truly a McBurney incision—many crimes, of course, have been committed in McBurney's name—often encounters his own troubles in getting out through such an opening an appendix that lies out of its normal location, Treves was perfectly correct and very wise when he pointed out years ago that the one thing constant about the position of the appendix is its inconstancy. In 3 cases in this series—by chance they happened to be consecutive cases—the appendix lay entirely out of reach through the McBurney incision which had to be converted into another type. Incision over the mass of course, is sufficient if a mass is demonstrable, and represents a very sound conservatism.

An analysis of the wound infections in this series (Table VII) shows several interesting things, the first of which is that the incidence of this complication seems to have very little

TABLE VII—WOUND INFECTIONS IN RELATION TO PATHOLOGY PROCEDURE, AND INCISION  
—52 CASES

Pathology	Cases
Acute	3
Rupture with gangrene	7
Rupture with gangrene and local peritonitis	2
Rupture with gangrene and pelvic peritonitis	1
Rupture with gangrene and general peritonitis	8
Rupture with local peritonitis	5
Rupture with general peritonitis	1
Gangrene	1
Gangrene with local peritonitis	1
Gangrene with pelvic peritonitis	1
Gangrene with general peritonitis	1
Abscess	4
Incision	
McBurney	24
Right rectus	1
Battle	5
Over umb.	
Procedure	
Appendectomy	3
Appendectomy with drainage	7
Appendectomy with drainage and omentectomy	2
Drainage only	

to do with the type of incision. It is true that nearly 25 per cent of the patients with right rectus incisions developed wound infections against only 19 per cent with McBurney incisions, but a higher percentage of the former group were drained, and it is our opinion that the incidence of this complication depends more upon the extent of the original pathology than upon any other single factor. None of the patients who died developed wound infections, probably because most of them made their exit so promptly.

In addition to this complication, and excluding the patients who died the following postoperative complications are represented in this series: fecal fistulae (3), hematoma of the wound, mild upper respiratory infections (4), bronchopneumonia (4), in addition to the 2 pre-operative cases, sinus arrhythmia brachycardia, edema of the scrotum, rectal hemorrhage, pyelitis (2), furunculosis, bed sores. One intestinal obstruction was handled successfully by ileostomy, 1 cul-de-sac abscess was drained by colpotomy and there was 1 case of evisceration with repair. Thirty-seven patients had a very rugged course, and in all of them the liberal use of fluids by all routes for many days after operation undoubtedly had much to do with the favorable outcome. Transfusion was done in 4 cases with good results. Many of these children were either in a state of acidosis, or on the verge of it, when they were operated on and its control was of great importance, for children do not tolerate

starvation well, whatever its cause may be. One child had a severe case of rheumatic heart disease and was fortunate to escape with his life, for 2 others, similarly afflicted succumbed.

In all but 6 cases operation was done promptly on admission and in 2 of these death occurred. In one instance the condition was considered incorrectly as it proved to be a subsiding subacute appendicitis, a diagnosis which was warranted from both the history and the findings on admission but operation disclosed a gangrenous appendix with general peritonitis a state of affairs entirely inconsistent with the clinical symptoms. The other fatality belongs in the group described by J B Hunter as the unsuccessfully delayed case, the type of patient who is in worse condition to withstand surgery because of delay than if he had been operated on promptly. Undoubtedly immediate operation is the wiser plan in children just as it is the wiser plan at any age. Hope deferred as Royster well says often maketh the patient sicker and that is particularly true of little children who do not tolerate the expectant plan of treatment and in whom even more than in adults, it is impossible to tell what a single hour may bring to pass. It became more and more our conviction as we studied these cases that the great majority of the patients who lived owe their lives to the promptness with which surgery was instituted. Indeed we have only commendation for most of the surgeons who handled the cases we threw out because the laboratory did not confirm the clinical diagnosis. The occasional unnecessary operation on a wrong diagnosis, as we have already pointed out is infinitely better than a delayed operation on a correct diagnosis, which terminates, as it frequently does, in a life lost. In other words under the proper safeguards, the look and see policy is far safer than the wait and see policy. In acute appendicitis the suspicion that one is dealing with acute disease will save many a patient who would be lost if the removal of all chronic and subacute appendices whose exact pathology were not certain should be deferred until the interval.

The causes of the 19 deaths, 10 of which were verified by postmortem examination include rheumatic heart disease (2) pneumonia pulmonary oedema anæsthetic (ether on the table) peritonitis and its complications (1) toxæmia (2 in 1 case with evisceration). Eleven of the patients died within 24 hours, 2 of them within 6 hours and while the mortality must be figured on the basis of the total number who died against the total number who lived it is not unfair at least to point out that a certain percentage of the children who died were beyond the reach of medical aid when they entered the hospital indeed were actually moribund and that surgery was resorted to not with the hope or expectation that their lives could be saved but simply as the surgeon's instinctive attempt at rescue, his instinctive gesture of succor.

#### SUMMARY

That this study of 250 cases of acute appendicitis in young children contributes anything new to the subject we are not fatuous enough to believe. That it emphasizes again certain considerations which can profitably be emphasized again we do sincerely hope. We have endeavored to make three chief points that the pathological process in children under 12 years of age is far more serious than it is in youth and early adult life even though the incidence is considerably lower that the gravity of the disease is dependent not only upon the inherent virulence of the infection but also upon the delay attendant upon the difficulties of diagnosis and upon the very frequent administration of drastic and lethal purgatives finally that the outcome in any given case, or any given group of cases, depends not so much upon the exact procedure adopted as upon the promptness with which it is adopted and the wisdom which correlates the pathological process present with the extent of surgery done. If we have brought to mind again these essential considerations in acute appendicitis in children we shall have fulfilled our own aims and shall have contributed, we trust, something of value in the study of this treacherous and highly fatal disease.

# REFERENCES

1. BERRY J. Fallen idols. The case of appendicitis. *Lancet*, 1932, I, 1027-1030.
2. BRONKEMANN, J. The abdominal pain of throat infections in children and appendicitis. *J. Am. M. Ass.* 1927 *lxxxix*, 2183-2186.
3. FARR, C. E., and BRACKLEY, S. Appendicitis in children. *Surg. Clin. North America*, 1928, *viii*, 1193-1222.
4. FREEDMAN H. J. Forty two cases of appendicitis occurring during an epidemic of upper respiratory tract infection. *Arch. Pediat.*, 1929, *xlvi*, 604-616.
5. HUNSON H. W. Preventable child deaths acute appendicitis. *New England J. Med.*, 1932 *ccvii*, 255-257.
6. GIBSTLEY J. R. Appendicitis in children. *Med. Clin. N. America*, 1930, *xiii*, 1175-1185.
7. MAES, U., BOYCE, F. F., and McFETRIDGE, E. M. Appendicitis over forty with a critical review of 100 cases. *Am. J. Surg.*, (in press).
8. PATTERSON E. W. Appendicitis in young children review of 100 cases. *Ann. Surg.*, 1929, *lxxxix*, 48-53.
9. ROYSTON, H. A. Appendicitis. New York: D Appleton and Co., 1927.
10. TASCHE, L. W. Appendicitis in children. *Am. J. M. Sc.*, 1931 *clxxxii*, 86-94.
11. WOODALL, C. W. A study of appendicitis in children under 12 years of age, with an analysis of 295 cases occurring in Ellis Hospital, Schenectady N. Y. *New York State J. Med.*, 1928, *xxviii*, 322-325.

## THE VENOUS PLEXUS OF THE OESOPHAGUS

ITS CLINICAL SIGNIFICANCE<sup>1</sup>

DONALD L. KEGARIES, B.S., M.D., ROCHESTER, MINNESOTA

Fellow in Medicine, The Mayo Foundation

**M**EDICAL literature contains an abundance of information concerning varieties of the oesophagus in connection with obstruction of the portal and hepatic venous pathway, anatomical studies have been reported and these reports have been quoted by others (6 8 9) However the normal venous plexus of the oesophagus, and the nature of the connection between the portal and caval circulations has received little consideration. Because of lack of this rather important fundamental knowledge the following study was undertaken.

Of the many specimens of which injection was made in this investigation it was possible to carry out the technique in 16 with sufficient accuracy for good results. Of this number 8 specimens were considered satisfactory for a detailed study.

## METHOD

Injections may be made into the venous plexus of the oesophagus through the coronary vein of the stomach on the portal side of the circulation or through the azygos major vein. The coronary vein of the stomach being the most direct route gave the best results. Figure 1 shows the coronary vein of the stomach and its connection with the oesophageal veins and other venous channels in that region.

## RESULTS OF INJECTIONS

The periesophageal plexus described by other workers was not demonstrated but in its place were found three or four longitudinal trunks with little or no cross anastomosis.

The submucosa of the oesophagus was found to be richly supplied with veins situated both above and below the muscularis interna, the former lying close to the mucosa or protective layer. All of these channels were closely connected by many communicating or perforating branches. Only in so far as the region above the cardia is concerned, the submucous plexus

was noted to be very poorly supported by loose connective tissue, thus not entirely confirming the findings of other investigators. In these preparations the veins at the cardia were found to be strongly supported due to the increased thickness of the muscularis interna. The mucosa was also more adherent in this region and was bound together by interlacing elastic fibers and connective tissue. The plexus of veins in the submucosa was found to be extremely variable, although conforming to a general type of distribution. Clinically and pathologically this plexus appears to be of the greatest importance.

In the 8 cases studied the presence of a fine capillary anastomosis between the caval and portal circulation at the extreme lower end of the oesophagus was established. These fine venules were found to run longitudinally in the long axis of the oesophagus, beginning at the mucocutaneous juncture, or line of termination of the columnar epithelium of the cardiac end of the stomach and extending upward for a distance of 4 to 5 centimeters, with absence of any cross anastomoses. This region corresponds to the so called anatomical cardia of the oesophagus. In 3 of the cases studied, in addition to the small venules already mentioned, several larger veins, 3 in each case were seen to cross the cardia.

Below the cardia the coronary vein of the stomach after giving off a few periesophageal branches, pierced the serosa and muscularis obliquely for several centimeters giving off two to four main branches or trunks in the submucosa. These gradually broke up into small anastomosing branches which just before the cardia was reached became broken up into numerous fine longitudinal capillary like structures to continue across the cardia as already mentioned (Figs. 2 and 3).

Above the region of the cardia the veins of the submucosa were free, due to the loose connective tissue framework which poorly

Abstract of thesis submitted to the Faculty of the Graduate School of the University of Minnesota in partial fulfillment of the requirements for the degree of Master of Science in Medicine. Work done in the Section on Pathologic Anatomy, The Mayo Clinic.

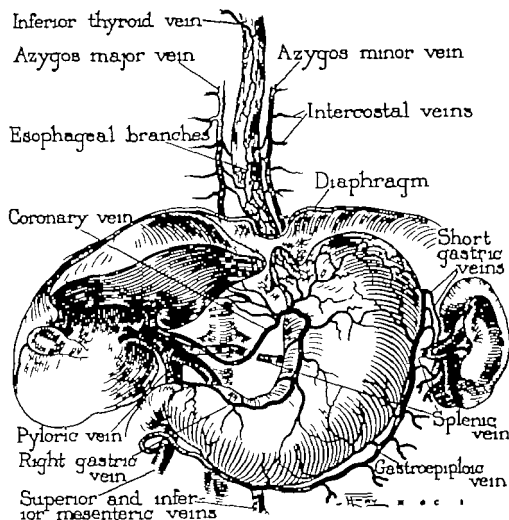


Fig 1 Coronary vein of the stomach and its connection with the oesophageal veins.

supported them. The veins in this situation were larger, and an abundant capillary network united the three or four main longitudinal trunks by cross anastomoses. The anastomotic radicles formed a dense network in the lower oesophagus but at the level of the bifurcation of the trachea the plexus became less complex (Fig 4). Below the latter point all sides of the oesophagus usually were well supplied with veins with no given preference for any certain region.

Large, saccular dilatations were seen along the course of the larger venous trunks in the submucosa of the oesophagus above the cardia. They were not artefacts since the injected mass did not diffuse into the surrounding tissues. Serial sections were made of one of these saccular structures and it was found to be a hemangioma, probably of congenital origin.

#### CONSIDERATION OF RESULTS AND SURGICAL ASPECTS

Failure to obtain satisfactory injection of the venous plexus of the oesophagus cannot be entirely ascribed to the inherent lack of anastomotic channels between the portal and caval circulations at the cardia, although such a condition must be recognized. It is possible that minute blood clots obstructed the finer venous radicles preventing the entrance of the injected mass, even though measures were used in an attempt to prevent such an occurrence.

The connection between the splenic and oesophageal veins is worthy of consideration. It seems possible that varices of the oesophagus may form independent of cirrhosis of the liver in diseases of the spleen, especially splenic anaemia and Banti's disease. Diminution in the size and number of the splenic



anuses obviously interferes with the outflow of the splenic blood and collateral channels must then necessarily be established. In this investigation an extensive connection was found to exist between the lower end of the esophagus and the spleen through the veins that accompany the vasa brevia and the coronary veins. Failure to block off this connection produced poorly injected specimens.

The results of injection of the veins of the esophagus seemed in general to answer the description given by Polner and Charpey. I was impressed by the minute size of the veins at the cardia. It is probable that this capillary like anastomosis at the cardia offers marked resistance to the flow of blood from the portal to the systemic veins, as is the case when the portal circulation becomes obstructed. In such instances the increase of venous pressure must exert itself on the veins below the cardia for some time before the resistance at the cardia is overcome. Varices result from an increased flow of blood through a vein, and from inability of the muscular and elastic fibers to withstand increased intravenous pressure. At the cardia as has been noted previously the submucous veins of the esophagus are well supported and it is reasonable to believe that the formation of varices first occurs below the cardia and secondly above that point after collateral channels of anastomosis have been established. Where several veins of large caliber cross the cardia, as has been noted in some of the cases, the formation of varices above the cardia is probably more rapid. When present, they are no doubt the first veins in the region of the cardia to become enlarged.

Ligation of the left coronary vein of the stomach in a case of hepatic cirrhosis associated with bleeding esophageal varices was first reported in 1929 by Walters, Rowntree, and McIndoe. Absence of melena following operation was noted. A further report was made by Rowntree, Walters, and McIndoe later in the same year. Here the bleeding esophageal varices were found in connection with Banti's disease the spleen and liver were both found to be enlarged. At the time of operation April 18, 1929 it was felt that the procedure was questionable because dilatation

of the coronary veins was not extreme. Splenectomy was considered at the time of operation but inasmuch as the new procedure meant less surgical risk, the vein was ligated. The patient made an uneventful recovery and returned home, but May 31, 1929 a severe hemorrhage occurred and he was almost exsanguinated. The spleen was removed July 17, 1929 and recovery was uneventful. Since then ligation of the left coronary vein of the stomach for bleeding esophageal varices has been carried out in 5 cases, with uneventful convalescence. The ultimate results, however cannot be stated at this time.

As a result of my study it seems doubtful that ligation of the left coronary vein of the stomach would have any beneficial effect on bleeding esophageal varices secondary to splenic anemia and Banti's disease. The extensive connection which exists between the veins that accompany the vasa brevia of the spleen and the veins of the esophagus precludes such a possibility. On the other hand, in hepatic cirrhosis associated with bleeding esophageal varices, ligation of the left coronary vein of the stomach is indicated since it interrupts the main flow of blood from the portal vein to the esophagus.

It appears reasonable that ligation of the veins that accompany the vasa brevia might be beneficial in cases of bleeding esophageal varices associated with splenic anemia and Banti's disease, especially in cases in which splenectomy would be considered a grave operative risk. The technique of ligating these veins would obviously be difficult, due to their poor accessibility and this might be a contra indication to such an operation. These procedures as has been mentioned, although still in an experimental stage, offer new possibilities in the treatment of such conditions. Sectioning of these veins in the course of splenectomy may explain the relief from serious hemorrhage which is often afforded by this procedure.

Walters has reported a considerable surgical experience with these cases (12) and recently (13) has suggested that an additional method of reducing the amount of venous blood in the esophageal varices might be injection of the periesophageal or paraesophageal plexus



Fig. 2.

Fig. 2. Injected lower part of oesophagus showing branching of coronary vein below the cardia.



Fig. 3.

Fig. 3. Lower two-thirds of injected oesophagus.



Fig. 4.

Fig. 4. Lower four-fifths of injected oesophagus. This

is the same specimen as that shown in Figure 2 but fewer details are evident. The figure is introduced here to show the disappearance of the veins as higher portions of the oesophagus are examined.

of veins with some non irritating yet sclerosing solution, a method similar to that employed for obliterating varicose veins of the leg. The solution should be injected through a very small needle so as to prevent undue bleeding from the needle puncture in the vein. Should bleeding occur, ligation of the vein at the site of the needle puncture could be carried out.

#### COMMENTS

Hæmorrhage from the submucous venous plexus of the oesophagus is always of serious moment. Clinically it is usually associated with varices of the oesophagus but it is apparently possible to have bleeding occur from the normal veins which occasionally assume sinus-like dimensions. The anatomical situation of these veins makes them susceptible to ulceration rupture and hæmorrhage. The combination of a number of factors is probably responsible for hæmorrhage from these veins.

Inflammation of the oesophagus is no doubt an important prerequisite for hæmorrhage. At the Mayo Clinic, one case has been seen in

which at necropsy a marked pseudomembranous oesophagitis was found. The epithelium was denuded and replaced by an exudate composed of polymorphonuclear leucocytes fibrin and erythrocytes. Large dilated venules in the submucosa were seen to be exposed by the ulcerative process (Fig. 5). The patient was a man aged 72 years who died of carcinoma of the head of the pancreas and bronchopneumonia. Blood was found in the stomach and intestines although a bleeding point could not be found in either situation. It is probable that hæmorrhage occurred from the oesophagus and was a factor in causing the patient's death.

Trauma may play a part in causing rupture of the veins. It is doubtful if the passage of an ordinary stomach tube is injurious in these cases according to Bartels. However a tube of the Rehfuess type which has a metal olive tip may produce enough trauma to cause hæmorrhage.

With impairment of the blood supply either through failure of arterial blood to reach the



Fig. 5 Pseudomembranous esophagitis showing exposed veins on surface (X22)

esophagus, or through venous congestion or stagnation the avascular epithelium is soon deprived of nourishment thus falling prey to infection and also to regurgitated gastric content containing acid and digestive enzymes. It is in such instances that varicosities, such as those associated with cirrhosis of the liver produce nutritional disturbances of the mucosa, edema and congestion of the submucosa, with consequent degenerative changes, infection ulceration and rupture of the esophageal veins.

Regurgitation into the esophagus of gastric content containing dilute hydrochloric acid and pepsin is not an uncommon occurrence. The incompetence of the cardia has been recognized by Alvarez Jackson Joannides and others. Robins and Jankelson observed true cardio-esophageal relaxation with regurgitation of barium into the lower part of the esophagus in 103 cases or 4.6 per cent of those patients examined roentgenographically and fluoroscopically. They expressed the belief that cardio-esophageal relaxation is not a clinical entity and that it can be demonstrated not only in diseased but also in normal persons.

In order to determine the relative frequency of esophageal regurgitation Kirklin and his associates at the Mayo Clinic observed 150 consecutive cases in which a complete gastrointestinal roentgenological study was made.

Each patient was examined in the recumbent and in the Trendelenburg position. Of the patients examined 15 (10 per cent) had very slight regurgitation of barium into the esophagus but not filling more than 2 inches of the distal third. In 2 cases there was marked regurgitation. Nausea was not experienced by any of these persons. If this is the finding among ambulatory patients, the frequency of regurgitation is probably high among those acutely ill.

Prolonged retention of acid and pepsin undoubtedly exerts a deleterious influence on a diseased or injured mucosa. This was demonstrated by Friedenwald Feldman and Zinn in their experiments on dogs. Prolonged vomiting especially the postoperative type, is probably most harmful to the esophageal mucosa, especially in association with a deficient circulation and the probability of hemorrhage from the venous plexus must be considered.

#### CONCLUSIONS

- 1 The submucous venous plexus of the esophagus has been demonstrated by injection through the coronary vein of the stomach in 8 of 16 cases or 50 per cent.

- 2 The presence of a periesophageal plexus of veins was not demonstrated, but rather a system of large venous trunks with absence of cross anastomoses.

3 Conclusive evidence of a channel of anastomosis between the portal and caval circulation at the cardio-oesophageal juncture in the absence of portal obstruction has been demonstrated

4 Results of other workers concerning a connection between the spleen and the oesophageal veins through the veins that accompany the vasa brevia have been confirmed

5 From this work one may conclude that the venous plexus of the oesophagus is a vulnerable structure and hæmorrhage may occur in conditions other than portal hypertension, such as cardiac decompensation diseases of the spleen and trauma or ulceration of the oesophagus

#### BIBLIOGRAPHY

- 1 ALVAREZ, W. C. The mechanics of the digestive tract. 2d ed. New York P B Hoeber 1928.
- 2 BARTELS, E. C. Personal communication to the author
- 3 FRIEDENWALD JULIUS, FELDMAN MAURICE, and ZOOK W F Experimental study of ulceration of the oesophagus. Tr Ass. Am. Physicians, 1928, xliii, 315-320.
- 4 JACKSON CHEVALIER The diaphragmatic pinch cock in so-called cardiospasm. Laryngoscope 1922 xxxii, 139-142 Bronchoscopy and esophagoscopy 2d ed., pp 71-73 333. Philadelphia W B Saunders Co., 1922
- 5 JOAKIMIDES, MIKAS. Influence of the diaphragm on the physiology of the esophagus and on the stomach. Arch. Int. Med. 1929 xlix, 856-861
- 6 JONNESCO, T Oesophage. In Pollier and Charpey Traité d'anatomie humaine. 2d ed. pt. 1 iv 200-201 Paris Masson et Cie. 1901-1905
- 7 KIRKLIN B R. Personal communication to the author
- 8 McINDOE, A. H. Vascular lesions of portal cirrhosis. Arch. Path. & Lab Med. 1928 v 23-42.
- 9 POIRIER, PAUL, and CHARPEY ADRIEN Traité d'anatomie humaine. 2d ed., pt. 1 iv 174-203. Paris Masson et Cie. 1901-1905.
- 10 ROBINS, S A. and JANKELSON I. R. Cardio-oesophageal relaxation. J Am Med Ass 1926 lxxvii 1961-1964.
- 11 ROWNTREE, L. G. WALTERS, WALTMAN and McINDOE, A. H. End result of tying of the coronary vein for prevention of hemorrhage from esophageal varices. Proc. Staff Meet. Mayo Clin. 1929 iv 263-264.
- 12 WALTERS, WALTMAN Discussion. Proc. Staff Meet. Mayo Clin 1932 vii 293-294
- 13 Idem. Discussion. Proc. Staff Meet. Mayo Clin 1933 viii, 163-165
- 14 WALTERS WALTMAN ROWNTREE, L. G. and McINDOE, A. H. Ligation of the coronary veins for bleeding esophageal varices. Proc. Staff Meet. Mayo Clin. 1929 iv 146-147

## THE DIAGNOSTIC VALUE OF THE DOUBLE CONTRAST ENEMA

WITH SPECIAL REFERENCE TO THE DIAGNOSIS OF EARLY NEOPLASTIC LESIONS OF THE COLON<sup>1</sup>

HARRY SHAY, M.D. AND J. GERSHON-COHEN, M.D. M.Sc. (Med.) PHILADELPHIA

From the Gastro-intestinal Clinic of the Jewish Hospital and the Roentgen Department of the Graduate School of Medicine of the University of Pennsylvania.

THE diagnostic value of the X ray is so dependent upon the contrast of shadows cast by the various ray traversed tissues that the roentgenologist is constantly on the alert to intensify these contrasts. That was the purpose of Fischer's (2) barium air enema better to distinguish the colonic lumen lesions which in their incipency are all too frequently obscured in the simple barium study.

The use of air as an aid in roentgenology is by no means recent having been employed in the study of the stomach and colon long before the insoluble salts of the heavy metals. As a medium for contrast visualization in colonic pathology it has not become popular because alone it generally fails to produce a demarcation from the neighboring partially air filled intestinal segments great enough to render the colonic outline distinctly visible. Air has frequently been injected into the colon in order to outline intra abdominal tumors and the lower border of the liver and spleen as well as into the bladder in order more clearly to demonstrate intravesicle growths, while the success of ventriculography and encephalography is dependent upon its presence.

The introduction of the insoluble salts of the heavy metals as an aid in the study of the gastro-intestinal tract has rapidly supplanted any use air as a contrast medium may have enjoyed. Unfortunately a satisfactory examination can not always be achieved with a barium or bismuth enema examination.

The difficulties encountered by the radiographer are due usually to his inability to fill the colon completely with the opaque mixture or to the inaccessibility to proper palpation of the splenic flexure, caecum and sigmoid. Satisfactory visualization and separation of redundant portions particularly in the presence of adhesions, are frequently unattainable. Confronted with these difficulties, Stewart also felt the need for additional studies, and

has devised a clever technique that operates in the sigmoid. The demonstration of early pathological mucosal processes like polyps, adenomata, ulcers, and carcinomata by means of the single contrast enema is too often impossible. Fischer recognized this inadequacy and returned to the use of air but in combination with the opaque salts the double contrast method. This causes the colonic walls to be covered with a thin coat of barium which in its turn is layered with a column of air. The result is an easy visualization of the entire colon no matter how redundant. Intraluminal growths, too, are sharply outlined as are even minimal lesions of the mucosa.

## TECHNIQUE OF THE DOUBLE CONTRAST ENEMA

A barium enema is given the patient by the usual technique. We use 8 ounces of barium sulphate to 1000 cubic centimeters of water our only precaution being to mix the two thoroughly. After the usual fluoroscopic and roentgenographic examinations, the patient is allowed to evacuate the colon and return for fluoroscopic study. Careful examination is made of the residual contents in the terminal ileum and colon and this is generally followed by radiographic record. Then the colon is inflated with air pumped by hand pressure through a short length of rubber tubing about two feet long a small Politzer bag with ball valve in the bulb being used. No special rectal catheters are used the ordinary hard rubber nozzle having been found satisfactory in all ordinary cases. If we are confronted with an incompetent sphincter an olive tipped catheter is used. We have found it unnecessary to use a stop cock device as described by Weber and Fischer because the ball valve in the rubber bulb has proved sufficient to eliminate almost completely any back-flow



Fig. 1a. Single contrast enema revealing feathery or shaggy outline of the cecal and cecocolonic margins, especially along the lateral aspects, which might be the result of inflammation, multiple diffuse polyposis, or retained fecal material adherent to the mucosa.

Fig. 1b. The double contrast study of the same colon—note the uniform coating of barium on the mucosa of the colon distal to the hepatic flexure as contrasted with the strungy mosaic like distribution on the mucosa of the ascending colon, at the same time, note the uniform continuity of the colonic margins of the ascending colon as contrasted with the same margins in the single contrast enema. A diagnosis of right sided catarrhal colitis was made from these findings.

of the opaque contents into the rubber tubing during the inflation. The colon is carefully observed fluoroscopically during this time and when it is altogether filled the inflation is halted. To avoid overdistention of the colon, the air is measured, making it equal to the amount of the opaque contents of the single contrast enema. If it takes 1000 cubic centimeters of opaque mixture to fill the colon, only 1000 cubic centimeters of air are used. The Politzer bag contains 250 cubic centimeters of air, it is therefore, comparatively easy roughly to estimate the quantity of air used. If the patient expels some air during the examination we compensate for it by greater inflation. Since all this is done under fluoroscopic control overdistention is avoided. We have never had greater ill-effects from inflating the colon with air than with the opaque mixture.

#### INDICATIONS FOR THE USE OF THE DOUBLE CONTRAST ENEMA

Kirklin and Weber have said that in many instances the double contrast enema study offers hardly more information than that of

the simple barium enema. Further that cumbersome and expense joined to this doubtful superiority preclude any advantage in its routine use. Agreed but we confess to an inability to prophesy which case will be the exception. Besides early or minimal lesions of the mucosa and small intraluminal growths are often completely obscured in the simple barium enema especially in a redundant colon. It must not be forgotten either that at present our only chance to manage malignancy derives from its early recognition or better still in the detection of precancerous lesions. Weber has shown how beneficial to the visualization of such lesions the double contrast method can be and Gershon Cohen has reported it as superior to the mouth meal method for the diagnosis of early ileocecal tuberculosis. We have reviewed the diagnostic benefits accruing from the routine use of double contrast enema in practically every form of colonic pathology. A value potentially so great, even though unpredictable is argument enough, we feel for use of double contrast enema routinely.



Fig. *a*. Single contrast enema revealing slight abnormal dilatation of the cecum, considerable elongation of the transverse segment, and diverticulosis of the pelvic and sigmoid segments.

Fig. *b*. Double contrast enema study of the same colon revealing an inverted cecum which accounts for the abnormal dilatation of the cecum in the single contrast films. Note the presence of a small intraluminal growth in the cecocolon just opposite the outwardly rotated valve—thus tumor mass was not visible in the single contrast films, nor were so many diverticula visible in the single contrast films.

Patient refused operation in spite of the presence of occult blood in the stools and a strong suspicion that the growth in the cecocolon was malignant. Death, 14 months later, followed by autopsy disclosed the presence of a large tumor mass of the cecocolon as shown by these roentgen studies. The histological diagnosis was papillary adenocarcinoma.

#### CORRECTION OF ERRORS DUE TO INCOMPLETE FILLING FÆCAL OR FLUID MASSES LOCAL SPAEM MEMBRANES AND ADHESIONS

It is too often with difficulty that defects in the colonic outlines from the simple barium enema can be designated real or apparent. No matter how painstaking the preparation of the colon to prevent false filling defects by retained fecal or fluid material such defects occur. While they are most often found in the cecum, cecocolon and sigmoid and although they can often be displaced on palpation they frequently necessitate a repetition of the examination before a definitive roentgenological opinion can be achieved. The double contrast enema establishes the falsity or reality of such defects by the changes or lack of changes in their positions and contours following injection of the air.

Local spasm often deforms colonic outlines making the distortion indistinguishable from real pathology. Such findings are particularly troublesome in the simple barium enema ex-

amination when the defect not observed fluoroscopically is first detected on the film. All complications of this kind are dissipated by the double contrast study. While spastic contraction may persist in the air film, it is rarely seen in the same segment in both the barium and the barium air films unless true pathology is present in which latter case, the lesion is usually more clearly visualized in the double contrast film.

While the various congenital and inflammatory bands and membranes are never actually discernible roentgenographically their presence may be suspected as a result of the impaired mobility of the involved intestinal segments, or of their abnormal placement, or of the examiner's inability to separate adjacent loops of bowel. Occasionally however the coupling of these bands or membranes with the overlapping of colonic segments defies all effort to visualize the outlines and contours of the involved loops in the single contrast films. Here again the double contrast enema



Fig. 3a. Single contrast enema examination showing elongation with redundancy and dilatation of the pelvic, sigmoid and rectal segments—also shaggy and irregularity of the cecal and cecocolonic margins. A suggestion of small circular filling defects is present in the midtransverse colon near the upper margins.

Fig. 3b. The same colon studied with the double contrast method. Note the regular continuity of the margins of the ascending colon with the presence of myriads of small more or less circular filling defects in the ascending, transverse and sigmoid segments. Also the stringy distribution of the residual coating of barium impregnated mucus on the walls of the descending and pelvic segments.

A diagnosis of diffuse polyposis of the colon with mild mucocolitis of the descending colon was made. The sigmoidoscopic examination revealed the presence of diffuse polyposis and mucus was persistently found in the stools.

clarifies the picture. In consequence, the colonic segments are clearly outlined, the fluid levels always discernible and the restricted mobility of the intestinal loops no matter how displaced or how firmly joined together always visible.

#### DIFFERENTIATION BETWEEN TRUE AND FALSE COLITIS

After the evacuation of the barium enema, the normal colon retains about 25 per cent, or less, of the barium. This residue upon fluoroscopic examination, is usually distributed in the cæcum, upper descending colon, and often in the sigmoid and rectum. After the air in jection a thin layer of suspension may be seen coating the mucosa. This gives a sharp, uniform etched colonic outline contrasting with the denser intraluminal air zones.

Variations in the barium coating indicate colonic irritation. They are, in all probability due to the amount of mucosal transudate or

exudate produced by the excitant of the colonic disturbance. The milder irritations present interruptions in the continuity of the etching lines. In others a plaque like distribution of the residual film of barium on the colonic mucosa is noticeable. More advanced cases of mucosal irritation produce greater irregularities in the distribution of the barium and often adopt a mosaic or lace like design. At times, detached casts of impregnated mucus or long strings of mucus lying free in the lumen are visible. Changes such as these are associated with different grades of true inflammation. In contrast irritable colon the result merely of spasm does not produce any variety in the distribution of the residual opaque coating of the mucosa.

#### DIVERTICULOSIS AND DIVERTICULITIS

While the simple barium enema readily reveals the presence of diverticula, the double contrast method permits refinements well



worth the additional effort. In the plain barium enema only those diverticula may be seen which project in the plane at right angles to the rays. Those in other planes will be obscured by the barium in the colon. The double contrast enema allows visualization of these diverticula in addition to the marginal ones. It thus gives a more complete picture of the number of diverticula and of their distribution. Too in the presence of a diverticulitis the exudate and transudate may so diminish the tenacity of the mucosal secretion that the barium will not adhere to the walls of the inflamed diverticula producing signs similar to those described under true colitis.

#### ILEOCECAL TUBERCULOSIS

Sampson has painstakingly elaborated a mouth meal roentgen examination for the diagnosis of ileocecal tuberculosis. These studies involve examination of the colon at frequent intervals between the fourth and tenth hours after ingestion. In addition to the multiple expensive examinations the interpretation of the roentgenograms presents a difficult problem. The normal variation in motility of the ingested column through the intestinal tract is quite wide. In early cases the frequent inconstancy of the localized hypermotility often results in doubtful evidence upon which to base a positive diagnosis.

Irritability in the terminal ileum and cecum where tuberculosis is most frequently localized is very easily uncovered. The presence of hyperperistalsis, antiperistalsis, pain tenderness, and changes in the outlines and contours of the terminal ileum and colon can all be quickly, thoroughly and convincingly demonstrated by fluoroscopic and roentgenographic examination by means of the enema methods. When we add to this the findings of the double contrast films the diagnosis can always be established and an accurate idea gained of the exact extent and degree of pathology.

In very early cases, abnormal peristaltic phenomena in the affected segments of the terminal ileum and colon are always seen fluoroscopically and the pseudo-filling defects due to these are always visualized in identical segments in both films. Unfortu-

nately the visualization of ulcers is seldom possible but considerable irregularity in the distribution of the residual opaque contents in the ulcerated areas is always the rule and stands out in sharp contrast to the normal segments of the colon where the residual opaque coating is uniform. The various changes in the appearances of the colon in the double contrast films have already been described in detail.

#### NEOPLASMS

The double contrast method has found its greatest usefulness in making visible intraluminal polypi and minimal neoplastic lesions of the mucosa so small as to be generally overlooked. Weber has pointed out how difficult it is consistently to visualize these types of colonic lesions in the simple enema. If the principles stressed by Moore for gastric polypi can be applied to the colon occasional recognition of a polypoid growth can be made with the simple barium enema but only if the tumor is large. In some instances the barium column fluoroscopically may show a momentary split as it passes the new growth—a finding which may be easily overlooked. In such cases the double contrast enema becomes of inestimable aid. In the barium filled colon small fungating or papillary growths may be completely obscured. Following the air injection these masses stand out in bold relief as areas of increased density in the clear air zones between the sharply etched colonic walls (Fig. 3). We have been convinced too many times by the demonstration of early young neoplastic growths in the double contrast films completely unsuspected and obscured in the single contrast films not to realize the desirability of routine use of the double contrast enema examination. This desirability is made a necessity if the life of the patient and the successful surgical treatment of cancer of the colon is put above the slight additional time and cost the double contrast studies entail. We know that these studies will result in the proper diagnosis of many obscure cases of intestinal bleeding due to precancerous and early malignant growths undetectable by the ordinary single contrast enema.

## BIBLIOGRAPHY

1. BROWN LAWRASON, and SAMPSON HOMER L. *Intestinal Tuberculosis*. Philadelphia: Lea and Febiger, 1926.
2. FISCHER, A. W. Ueber die Roentgenuntersuchungen des Dickdarms mit Hilfe einer Kombination von Lufteinblasung und Kontraststromlauf. *Arch f. klin. Chir.*, 1925 cccxv 300.
3. GREENHOW-COHEN J. The diagnosis of early ileocecal tuberculosis. *Am. J. Roentgenol.* 1930, xxiv 367.
4. KIRKLEN B. R. and WISNER, H. M. Roentgenologic manifestations and differential diagnosis of carcinoma of colon. *New York State J. Med.*, 1932 xxxii, 843.
5. MOORE, A. B. A roentgenologic study of benign tumors of the stomach. *Am. J. Roentgenol.*, 1924, xi, 61. Benign tumors of the stomach from the roentgenologic point of view. *J. Am. M. Ass.*, 1927, lxxxix 368.
6. STEWART W. H., and ILLICK, H. E. Method of more clearly visualizing lesions of sigmoid. *Am. J. Roentgenol.* 1932, xxviii, 379.
7. WISNER, H. M. Roentgenologic demonstration of polypoid lesions and polyposis of large intestine. *Am. J. Roentgenol.*, 1931 xxv 577.

## THE ETIOLOGY OF UTERINE FIBROIDS

WITH SPECIAL REFERENCE TO THE FREQUENCY OF THEIR OCCURRENCE IN THE NEGRO  
AN HYPOTHESISJ THORNWELL WITHERSPOON M.A. (OXON) M.D., AND VIRGINIA W BUTLER, M.S.  
NEW ORLEANS, LOUISIANA

IN a recent communication we attempted to show that ovarian dysfunction resulting in follicular cystic changes in the ovaries, was a possible factor in the causation of fibroids. It is a generally accepted fact that hyperplasia of the endometrium is caused by estrin stimulation, unopposed by any corpus luteum influence, and with a possible anterior pituitary factor in the background. That this excess estrin stimulation or hyperestrinism, should be limited to a single uterine layer, the endometrium, did not seem reasonable especially since the uterus as a whole is involved in the reproductive process. It seemed logical to us that the myometrium should also be involved, especially if there be pathological stimulation to this myometrial layer at the same time that the endometrium is being abnormally stimulated to hyperplastic formation. But, since the rate of growth of fibromyomata is not exceedingly rapid except in pregnancy, malignancy, and possibly in youth, their appearance would be slower than the hyperplastic endometrial changes. Hence, it might be concluded that the unopposed action of estrin on the uterus would result (1) in immediate endometrial changes, characterized by hyperplasia, and (2) in more latent myometrial pathology in the nature of fibromyomatous growths.

Using this hypothesis as a basis in this recent paper we analyzed 150 cases of white women with hyperplasia of the endometrium, associated with follicle cystic changes, and we offered the findings of the ovaries, endometrium, and myometrium as evidence substantiating a cause and effect relationship between ovarian follicle cyst formation with hyperestrinism, hyperplasia of the endometrium, and fibromyomatous growths in the myometrium.

We feel that any explanation that can be offered as a possible cause of uterine fibroids must take cognizance of the frequency of their occurrence in the negro woman. That race is an etiological factor has not been scientifically proved, but in Charity Hospital, New Orleans where the annual admission of white and colored patients is about equal, uterine fibromyomata were noted nine times as frequently in the colored woman as in the white. Balloch describes this type of growth as a racial peculiarity, although there is a general impression extant that these tumors are unknown among primitive savage tribes. Moreover, Mouchet and Gérard remark that the fact which impresses medical missionaries in Central Africa is the rarity of neoplasms in the blacks, and that one is forced to believe that the negro presents a particular immunity to this affection.

In addition Surmont and Sava, after a life time study of the black race in Africa not touched by civilization agree that there is a rarity or even absence of malignant tumors outside the white races. They were able to report only 5 cases of fibroids of the uterus, and 3 cases found at autopsy were associated with ovarian follicle cysts. Why there should be any relationship between the development of uterine fibroids and the advancing civilization of the negro woman is difficult to understand unless as will be emphasized in this paper ovarian dysfunction resulting from chronic pelvic infection usually gonorrhoeal plays an etiological rôle.

Those of us who have been raised in the South side by side with the negro have been imbued with the fact of the prevalence of gonorrhoea in the negro race and those of us who have practiced medicine among the negroes have a full realization of the basic truth of this teaching. Of 6,918 patients with pelvic disease admitted to Charity Hospital 69.1 per cent were colored. A second pertinent observation on the colored woman is the frequency of fibroids in Charity Hospital of 2,991 cases of fibroids, 89.9 per cent were in the negro woman although the total gynecological admissions were only slightly greater in the negro than in the white. Miller comments that from one third to one-half of all colored women over 50 years of age present this type of growth, while as far back as 1872 Peaslee noted that few negro women over 40 years of age who died at the House for Colored Incurables in New York were free from this growth.

The great frequency of occurrence of these two diseases in the negro chronic pelvic inflammation usually specific and uterine fibroids, is so overwhelming that it is natural to attempt to associate one with the other but owing to the fact that it is characteristic of the negro to bear pain rather than place herself in the hands of a physician or in a hospital the two conditions are often so extensive and complicated that it is difficult to determine which is the primary pathology. Before making an analytic study of the association of these two conditions, therefore it may be instructive to look into the racial

heredity of the negro since, as already stated, it is difficult to understand why there should be any relationship between the development of uterine fibroids and the advancing civilization of the negro woman.

Matas, in 1896 wrote a masterly description of the surgical peculiarities of the negro, and from this article we have mainly abstracted the following historical and racial characteristics. With very few exceptions, the negroes of our North American continent are directly descended from the black slaves imported from Africa during the slave traffic. This trade drew from the diversity of tribes that inhabited the vast African areas along the coast and in consequence a great variety of negro types were introduced into the American colonies. These types however have gradually fused so that the present typical American negro is a truly composite type which has incorporated in it all the generic characteristics of the West African tribes. At present there remain comparatively few of the pure black type since according to the 1928 census one fifth of all American negroes exhibit some strain of white or Aryan blood. Yet to those of us who are not ethnologists, the present American negro exhibits overwhelmingly the characteristics of the Guinea (Congo Louisiana) type, that is, woolly hair, black skin, thick lips, a broad flat nose, prognathous jaws, a narrow and receding forehead, a slender waist, high hips, slender and massive feet which are rounded at the bottom. The two other pure negro strains that are occasionally seen are the Yollofis characterized by woolly hair, jet black skin, a fine form and strictly European features and the Caffres, who exhibit woolly hair, a blackish-brown complexion and have both fine features and form.

What has been the effect of the infusion of white or Aryan blood into the original pure negro type is a difficult question to answer. Some information is gained from Quatrefages, who in the *Human Species* translated into less technical phrases, says when the disturbing factors or the cause of a disease or injury act upon a fundamental element, the same causes will produce fundamentally similar effects when on the contrary this action is exercised upon the acquired element of each

race the same causes will produce different effects.

The diseases which were at one time so common and specific to the colored race, yaws African sleeping sickness, elephantiasis, etc. have practically disappeared from this country, whereas the almost absolute immunity of the negro to malaria, yellow fever scarlatina diphtheria, gastro-intestinal diseases nervous disorders, gout, etc.,—definite evidences of acquired racial differentiation—has been completely modified in less than 300 years, until at present the negro is almost as susceptible to these diseases as is his white brother. In short the general comparative immunity of the negro to certain diseases in the earlier period of this country's history has been impaired by his long residence in a new habitat, and now cancer, tuberculosis, and syphilis at one time practically unknown to this race are exerting a deteriorating influence upon the physical stamina of a race that is possibly inadequately prepared for it. Today the negro is not only sharing the physical tribulations of the white race, but is, in reality developing hitherto unknown morbid predispositions to certain diseases that affect the white race and a tendency to exhibit loss of specific racial immunity to pathological peculiarities which it acquired during the original process of race differentiation in Africa.

Balloch in 1894 was one of the first observers to call attention to fibroid processes in the dark skinned races especially elephantiasis Arabum keloids and uterine fibroids. He cites purposeful keloid formation in the savage tribes as cosmetic adornment and tribal identification, we however have been unable to find any evidence in medical literature of the association of keloids and uterine fibroid formation. That keloids and elephantiasis Arabum are frequent findings among the savages is a known fact but definite evidence is still wanting, as brought out by the report of Surmont and Sava to confirm a similar frequency of uterine fibroids. In fact, the opposite opinion is generally held that fibromyomata of the uterus are unknown among the primitive tribes, and are a disease of advancing civilization. If this be true, uterine fibroids are not the result of a racial inheritance, as postu-

TABLE I

Age	58 years	24 years	36.8 years	Case	Per cent
Oldest					
Youngest					
Average age					
Social status					
Married				106	
Single				13	
Not mentioned				6	
Fertile				64	60.3
Sterile				34	32
Not mentioned				13	
Menstrual history					
Menorrhagia				55	
Metrorrhagia				10	
Dysmenorrhoea				22	
Amenorrhoea				3	
Menopause				1	
Normal				16	
Not mentioned				31	
Chief complaint					
Tumor				57	
Pain				65	
Bleeding				10	
Not mentioned				6	
Myometrium					
Hypertrophied				92	
Fibroid				23	
Not mentioned				6	
Endometrium					
Hyperplastic				38	
Atrophic				51	
Normal				5	
Not mentioned				31	
Ovaries					
Cystic				121	96.8
Fibrous				41	
Corpus luteum				4	
Dermoid cyst				1	
Both ovaries, or total ovarian tissue				85	68
Tubes					
Salpingitis				125	100
Wassermann					
Positive				28	22.4
Previous operations					
Oophorectomy					
Unilateral salpingectomy				4	
Bilateral salpingectomy				3	
				6	
Pregnant				1	
Hemorrhaphy				1	
Dilatation and curettage				2	
Appendectomy				1	

lated by Balloch but are caused by some acquired influence. Moench who offers localized pelvic congestion and overactivity of the ovarian hormone as a theory for the etiology of fibroids assigns as a reason for the frequent incidence of the disease in the American negro as compared with the African black the fact that the strict rules of sexual abstinence of the

Africans make these tribes distinctly undersexed in comparison with the civilized white woman organs below par respond to stimulation by an excessive reaction. All of this may be true but to those of us who live in the South this theory sounds more fanciful than truthful since an undersexed negro of pure strain is at present only a myth and the sexual promiscuity of the negro has made sexual intercourse almost synonymous with social intercourse.

If we may conclude negatively because of lack of positive evidence that uterine fibroids are not the result of a racial peculiarity since (1) they are present also in the white race, and supposedly not in the pure primitive stock and (2) that no report of a definite association between keloids and uterine fibroids could be found we are then forced to admit a relationship between fibroid formation and the advancing civilization of the negro woman. In other words uterine fibroids are the result of an acquired influence not of an inherent trait.

We believe that the source of this acquired influence is to be found in the chronic pelvic disease of the negro giving rise to an inflammatory reaction around the ovary, which results in ovarian dysfunction and abnormal hormonal secretion in the nature of hyperestrinism whose action on the uterus, as suggested, is immediate endometrial changes characterized by hyperplasia and more latent myometrial changes in the form of fibromyomatous growths.

Using this hypothesis as a basis, we have noted that Alsbrook reports 99.1 per cent salpingitis associated with 1000 cases of fibroids in the negro. In the present series of 125 cases of fibroid growths in the negro woman pelvic inflammatory disease in the nature of salpingitis oophoritis, pelvic abscesses, pus pockets, adhesions, etc. was observed in every instance. In addition the ovaries exhibited follicle cyst formation in 121 cases, or 96.8 per cent. Table I is offered, presenting the myometrial, endometrial, and ovarian findings in the 125 cases of fibroids in negro women. Unfortunately due to the inadequacy of the records, the condition of the endometrium was not often diagnosed microscopically but merely commented upon

grossly. We, therefore, feel that the endometrial findings as given here are of little value.

#### SUMMARY AND CONCLUSIONS

In a previous paper we have offered evidence from 150 cases of fibroids in white women which we believe to be convincing in support of an hypothesis that ovarian follicle cyst formation with hyperestrin secretion, is an etiological factor in the formation of (1) hyperplasia of the endometrium and (2) fibromyomatous changes in the myometrium, provided the stimulation is prolonged sufficiently. Because of the greater frequency of fibroids in the colored woman we have attempted to apply this hypothesis to this race, and we feel that the ovarian and myometrial findings from 125 cases of fibroids in the negro are additional evidence which confirm the original hypothesis. Our belief is that uterine fibroid development in the white and colored woman has the same source namely prolonged estrin stimulation resulting from ovarian follicle cyst formation but that the negro presents a greater frequency of occurrence of fibroids because chronic pelvic infection resulting in ovarian damage and dysfunction is more common in her than in the white woman and this abnormal ovarian secretion, the stimulation of which remains permanent, is prolonged sufficiently to be the igniting factor in the development of fibromyomata.

It would seem, however that pelvic infection giving rise to disturbed blood supply follicle cysts thickened ovarian capsules, abscesses, etc. is not the only source of ovarian follicle cyst formation. In the white woman, in whom chronic pelvic diseases are not so common, and especially in the white virgin, in whom pelvic infection is definitely ruled out, we believe ovarian follicle cyst formation is the result of a general glandular disturbance inherent in the organism as a whole.

Moreover we doubt that this ovarian damage in the white woman need necessarily be permanent. Often it is not prolonged sufficiently to cause latent fibromyomatous myometrial changes even though the immediate hyperplastic endometrial changes be present, since we frequently in our clinical experience see women who in early life exhibited hyper

plasma of the endometrium and, necessarily, ovarian follicle cysts, later pass through the normal reproductive process, and the former glandular disturbance readjusts itself.

In conclusion, we offer as an explanation for the frequency of fibroids in the colored woman, the fact that ovarian follicle cyst formation, resulting from mechanical blocking, due to a thickened capsule, or disturbed blood supply from chronic pelvic inflammation is a frequent finding, and when once initiated the hyperestrin secretion persists since the damage is permanent, as long as ovarian tissue remains active. On the other hand in the white woman, ovarian pelvic inflammation is a much less frequent finding and often the ovarian follicle cyst formation is a result of general glandular upset and therefore is not permanent, if a glandular readjustment can be obtained.

In this fact of permanent and continuous stimulation of hyperestrinism on the myometrium, prolonged sufficiently to cause uterine fibroids, we believe there lies a convincing explanation for frequency of fibroids in the negro.

#### BIBLIOGRAPHY

1. ALMOND, H. B. One thousand cases of uterine fibroids in the negro race. *New Orleans M. & S. J.* 1931-1932 lxxiv 317.

2. BALLOCH, E. A. The relative frequency of fibroid processes in the dark-skinned races. *Med. News*, 1894, lxi, 29.
3. BRENNER, A. G. Keloid formation in the negro. *Ann. Surg.*, 1913 lxi, 83.
4. COHEN, J. Uterine fibroids. an analysis of 1000 consecutive cases. *South. M. J.*, 1930, xliii, 875.
5. DAY, G. H. Urological and venereal idiosyncrasies presented by the negro. *J. Urol.* 1931 v 19.
6. MATAS, R. The surgical peculiarities of the negro. *Tr. Am. Surg. Ass.*, 1896, xiv 483.
7. MILLER, C. J. A comparative study of certain gynecological and obstetrical conditions as exhibited in the colored and white races. *Am. J. Obst. & Gynec.* 1928 xvi, 668.
8. MILLER, C. J. A review of 150 cases of fibroids of the uterus. *New Orleans M. & S. J.* 1923-1924 lxxvi, 461.
9. MOENCH, G. L. The etiology of adenomyositis and uterine fibroids: an hypothesis. *Am. J. Obst. & Gynec.*, 1929, xvii, 682.
10. MOUCHET and GÉRARD. Cancer and the negroes of Central Africa. *Bull. Soc. path. exot.*, 1926 xix, 564.
11. PRASLEY, R. Ovarian Tumors. New York D Appleton & Co., 1872.
12. ROSSER, C. Protologic peculiarities of the negro: a fibroplastic diathesis. *Am. J. Surg.*, 1923 xxxvii, 265.
13. SORMONT and SAVA. Concerning the non-civilized populations of the black race in Africa. *Bull. de l'Ass. franc. p. l'étude du cancer* 1927 xvi, 136.
14. TIFFANY, L. Comparison between the surgical diseases of the white and colored races. *Tr. Am. Surg. Ass.* 1887 v 261.
15. WITHERSPOON, J. T. The interrelationship between ovarian follicle cysts, hyperplasia of the endometrium, and fibromyomata. *Surg., Gynec. & Obst.* 1933, lvi 1026.

# CLINICAL SURGERY

FROM THE ROYAL WATERLOO HOSPITAL LONDON

## TECHNIQUE OF SPLENECTOMY

RODNEY MAINGOT F.R.C.S. (Eng.) LONDON ENGLAND

Senior Surgeon to the Royal Waterloo Hospital, London and to the Southend-on-Sea General Hospital

THERE are many ways of performing the operation of splenectomy and these will vary with the technique employed by the individual surgeon and the particular circumstances which call for removal of the spleen. The operation may be one of great simplicity when the organ is of normal size, or if enlarged, when there are no binding adhesions. On the other hand, in certain conditions in which splenectomy is clearly indicated, the technical difficulties may be so great that the operation may have to be abandoned altogether. In some cases of splenomegaly the organ may be so inextricably tethered to the diaphragm and adjacent viscera that it becomes a physical impossibility to mobilize the spleen and ligature off its anomalous vascular pedicles.

There are certain features in the technique of the operation which I propose to emphasize in this article as they are not generally appreciated or have been somewhat neglected in descriptions of the operation.

Figure 1 shows diagrammatically the two vascular pedicles of the spleen, and the somewhat complicated visceral reflections of the peritoneum in the region of the hilum. It demonstrates the necessity of securely ligaturing and dividing the gastrosplenic omentum before dealing with the true pedicle which contains the splenic artery and vein.

It is most important to ensure that the stomach is empty and flaccid before the operation is commenced by passing a small stomach tube and aspirating the contents. If the stomach is distended with gas or fluid it will push the spleen into an even more inaccessible position, in addition to rendering all intra-abdominal manipulations more cumbersome, difficult, and not free from danger in so much as the stomach itself may receive some injury when the uppermost portion of the gastrosplenic omentum is ligated. It is un-

likely that the stomach will contain any fluid except in cases of trauma of the organ, but if an inhalation anæsthetic is being given it is usually distended with gas. A stomach tube, therefore, which has been introduced before the operation, and left *in situ* until it is completed, ensures an empty stomach, and simplifies the further steps in the operation.

There are four important stages in the operation (1) the abdominal incision and exposure of the spleen, involving the question of choice of incision (2) the freeing of adhesions, the mobilization of the spleen, and its delivery through the abdominal wound (3) the methods of securely ligaturing the vascular pedicles (4) closure of the wound and ensuring meticulous hæmorrhage of the blood vessels in the anterior abdominal wall.

1. *Incision and choice of incision.* Numerous incisions have at one time or another been employed for splenectomy but I shall describe only the four which I would myself recommend for the reasons given.

a. *Midline incision* (Fig 2 A) This is indicated in cases of rupture of the spleen, as it is easy to make and easy to close besides affording satisfactory access to the spleen and permitting inspection of the liver and the other important viscera of the upper abdomen, which may or may not be implicated. If any difficulties are encountered during the operation, a ready approach to the spleen will be obtained by cutting the left rectus muscle transversely through one of its tendinous intersections.

b. *Paramedian incision* (Fig 2 B) This is recommended for the majority of cases of splenomegaly and is one that is preferred by most surgeons. The incision does not in any way damage the rectus muscle, gives a good exposure, and subsequently a sound scar. There is, however, the drawback that the employment of this incision

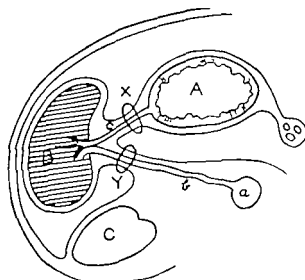


Fig. 1 Vascular pedicles of the spleen. *X*, False pedicle (gastrosplenic omentum) *F*, True pedicle (lienorenal ligament) *A*, Stomach. *B*, Spleen *C*, Kidney *a*, Aorta. *b*, Splenic artery *c*, Vasa brevia.

may protract the operation by a few valuable minutes

*c. Transrectus muscle incision* (Fig 2 C) This is the incision I have used in the majority of my cases. It commences over the costal margin and proceeds vertically downward to the level of the umbilicus. It is placed at the junction of the middle and inner third of the left rectus muscle, and traverses all the structures of the anterior abdominal wall in the same plane. It gives ready approach to the spleen, and is particularly easy to sew up rapidly. I have never seen a post operative ventral hernia develop after the employment of this incision but I have cases which show definite weakness of the inner fibers of the muscle.

*d. Subcostal incision* (Fig 2 D) This incision begins at the tip of the xiphisternum and runs obliquely outward and downward two fingers-breadth below the costal margin. The rectus muscle and the muscles of the lateral abdominal wall are divided in the line of the incision. It is in fact, similar to Kocher's gall bladder incision on the opposite side and should be employed for those cases in which splenectomy is called for in very obese patients. If this wound is carefully sutured there is no risk of subsequent hernia.

There are three important points, therefore which should characterize all these incisions (1) They should be large and generous, so that there is no hampering of the intra-abdominal manipulations. (2) Special pains should be taken to see that wound hemostasis is thorough and complete. Neglect of this may, owing to the condition of the

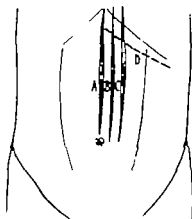


Fig. 2 Incisions for splenectomy. *A*, Midline. *B*, Paramedian. *C*, Transrectus muscle. *D*, Subcostal.

blood in such patients, lead to subsequent hemorrhage, or a dangerous—possibly fatal—oozing. (3) Closure of the wound should be performed carefully and tension sutures inserted as a precautionary measure against burst abdomen or postoperative ventral hernia, which are by no means infrequent complications.

*2. Freeing of the adhesions the mobilization of the spleen and its delivery through the abdominal wound.* As soon as the abdomen is opened the first step should be a rapid but complete exploration of the liver, gall bladder and its ducts, the pancreas, stomach, and duodenum. If not performed as a routine at this stage it may be forgotten or omitted after the splenectomy and some important concomitant or independent intra abdominal lesion be overlooked which will subsequently mitigate or completely destroy the benefits of the operation. It will be noticed that as a result of passing the stomach tube the stomach lies high up tucked underneath the liver empty and contracted. If the viscus, however is still distended the stomach tube should be reinserted and left in position during the remainder of the operation. Both edges of the wound are now well retracted to the right hand and to the left, and any adhesions which readily present themselves should be carefully divided and ligatured off. It is quite common to find slight adhesions between the spleen and the anterior abdominal wall or the spleen and the transverse colon. These should be picked up and divided between artery forceps and ligatured off before proceeding further. The spleen should then be carefully palpated its size and consistency should be gauged its mobility ascertained, and the presence or absence of adhesions between the spleen and the diaphragm noted before deciding upon the next step in the operation.



A careful search should be made for an accessory spleen or *splenucci*. It is stated that an accessory spleen is present in 10 per cent of cases. My experience is that the incidence has been under estimated, and while in normal subjects this figure may be correct, in cases of splenomegaly and in certain other diseases of the spleen such as essential thrombocytopenic purpura haemorrhagica, it is very much greater. In 7 of 12 cases of essential thrombocytopenic purpura haemorrhagica I have found more than one splenucci to be present—58 per cent. These accessory spleens or splenucci have no fixed anatomical position. They are usually found, however at the lower pole of the spleen, in the lower half of the gastrosplenic omentum or in the great omentum. They vary considerably in size and shape but generally they are circular about the size of a marble, although at other times they may be oval or disc like. They receive their blood supply from branches of the left gastro-epiploic artery *vasa brevia*, or the splenic artery itself.

If a splenucci is found at operation it should be excised in all cases except where the spleen has been removed for rupture as it partakes of the same morbid processes or malign characteristics as its mammoth forebear and cases are recorded in which a splenucci, after splenectomy has grown as large as a normal spleen.<sup>1</sup>

The various subsequent steps of the operation will be governed by the following factors (a) the size of the spleen (b) the presence or absence of adhesions between the spleen and the diaphragm, (c) the length and mobility of the lienorenal ligament.

If the spleen is small or normal in size or even somewhat enlarged if there are no adhesions or if any exist they are very slight, and if the lienorenal ligament permits of some mobility of the organ, the procedure should be as follows. The lower two-thirds, or even more of the gastrosplenic omentum is transfixed and ligatured off the ligatures being placed nearer to the spleen than to the stomach, as it is very easy to damage the stomach or to include a portion of it in a ligature (Fig. 3).

The remaining third of the gastrosplenic omentum is transfixed and ligatured after the spleen has been delivered through the wound. The left hand is then passed behind the spleen, which is drawn away from the diaphragm and the chest wall over to the right thus bringing the posterior aspect of the lienorenal ligament into view. With scissors or a long knife the posterior leaf of this ligament is divided when a further mobilization of

the organ will be rendered possible. The underlying areolar tissue and fascia propria are further incised (Fig. 4) and with the finger or a little gauze dissection, the tissues are separated, permitting of an even further freeing of the spleen.

This step is most important, and may be regarded as the key to the whole operation, as it is the lienorenal ligament which binds the spleen down in its hidden retreat in the abdominal cavity. When the lienorenal ligament is very mobile it is possible to deliver the spleen through the abdominal wound without employing this method.

3. *Methods of securely ligaturing the vascular pedicles.* The spleen is now quite free, and can easily be drawn fully through the abdominal incision. After any remains of the gastrosplenic omentum are dealt with and after the tail of the pancreas is identified and stripped away from the main vessels, the main vascular pedicle is ready to be ligatured (Fig. 5). A large hot, moist Cripps pad is now placed in the space that was formerly occupied by the spleen to control effectually any oozing from raw surfaces in this area. After isolating the vascular pedicle it is clamped with three large forceps (Fig. 6).

In doing this the operator places the left index finger behind the pedicle from above downward, and lifts the pedicle forward to ensure that the forceps are applied by sight and that in their application no damage is done to the pancreas, stomach, or colon. This is the three-clamp method of Föderoff.

The spleen is then removed by severing the pedicle with a knife between the middle and distal haemostats. The inner or medial haemostat is then removed thus leaving a groove or crushed area in the pedicle (Fig. 7).

Figure 8 shows the method of ligaturing off this pedicle. Two stout 20 day chromic catgut ligatures are applied to the groove and tied side by side, while each individual vessel distal to this is picked up with a haemostat and ligatured off separately. After ligaturing the last blood vessel and removing the Cripps pad the appearance will be as presented in Figure 10. A strip of adjacent omentum is drawn over the rough surface of the pedicle and held in position by a stitch or ligature, so that no raw surface remains at the completion of the operation.

In cases of *splenomegaly* in which the spleen is greatly enlarged the procedure will be different. The gastric surface of the spleen and the gastrosplenic omentum at once come to view when the peritoneal cavity is opened. The spleen lies closely applied to the greater curvature of the stomach, the gastrosplenic omentum is vertically

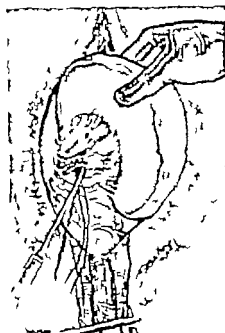


Fig. 3



Fig. 4

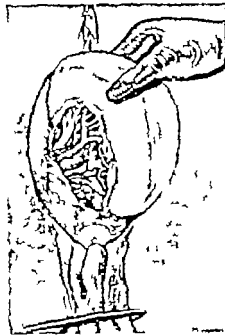


Fig. 5



Fig. 6

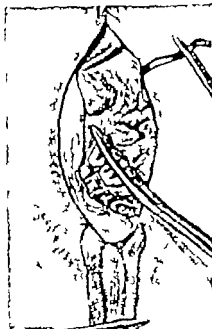


Fig. 7



Fig. 8

Fig. 3. Gastrosplenic omentum displayed. Ligature of blood vessels in gastrosplenic omentum.

Fig. 4. Mobilization of the spleen by division of the posterior leaf of the lienorenal ligament.

Fig. 5. The gastrosplenic omentum has been ligatured, and the blood vessels in the lienorenal ligament are shown.

Fig. 6. The three-clamp method of Fédoroff for dealing with the pedicle.

Fig. 7. The spleen has been removed. The crushed grooved area which is left after the removal of the medial hemostat is shown ready for the application of the ligatures.

Fig. 8. Two stout ligatures are applied to the crushed groove, and the individual blood vessels distal to this are ligatured off separately. Note the position of the Cripps' pad.

lengthened and horizontally shortened and the blood vessels are enormously enlarged and increased in numbers. This enlargement is particularly prominent near the upper pole of the spleen, and is very noticeable in cases of splenic anemia. Each of these blood vessels in the gastro-

splenic omentum will have to be carefully and individually underrun with an aneurysm needle, and ligatured with thick catgut or silk.

After all the blood vessels in the gastrosplenic omentum have been dealt with the right hand should be passed at the back of the spleen. Ad-

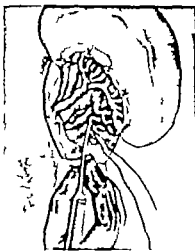


Fig. 9. The blood vessels are ligatured separately.

Fig. 10. Appearance after splenectomy. Three sutures have been applied to the bleeding points on the diaphragm.

hesions here in this remote area are invisible and will have to be separated with the finger. Bleeding may be sharp and troublesome at this stage, but the stripping and breaking down of adhesions will have to be proceeded with, as it is essential to free the organ posteriorly so that it can be drawn or hooked over to the right to display the peritoneum which forms the posterior leaf of the lienorenal ligament. As soon as the spleen has been coaxed out of its bed and has been drawn well over to the right, the subsequent stages for the further mobilization of the spleen are similar to those described above (Fig. 4).

A hot Cripps pad soaked in saline is packed against the diaphragm to control bleeding for the time being. As complete mobilization as is possible should be attempted and facilitated by turning the spleen over to the right on its pedicle as a hinge, and carefully separating the tail of the pancreas. In some cases of splenomegaly the splenic artery and vein may be enormously enlarged, friable, tortuous, and sacculated. In advanced cases of Banti's disease I have noted that their size may vary from  $\frac{1}{4}$  inch to  $1\frac{1}{4}$  inches in diameter. Each individual blood vessel is most carefully separated and with scrupulous care an aneurysm needle, carrying a very stout ligature, such as floss silk, is passed round it (Fig. 9) and the vessel ligatured in two places fully  $\frac{1}{4}$  inch apart. It is advantageous to tie off the main branches of the artery first, so that some of the blood from the spleen may be drawn back into the circulation. Each vessel that is doubly ligated is then severed between the ligatures, and

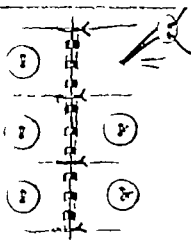


Fig. 11. Closure of the wound.

this procedure is repeated step by step until the whole vascular sheath has been dealt with. The veins are particularly friable and the ligatures may cut through them and start a very troublesome hemorrhage. I remember one case of splenomegaly in which I had to use No. 8 plaited silk to ligature the blood vessels, as the catgut ligatures when tightened led to rupture and even severance of the venous trunks at the seat of ligation. It is possible, too, for the blood vessels to rupture proximal to the ligatures, and I have known a case in which this occurred with a fatal result. It is obvious that in these cases, because of the increased size of the pedicle, the three-clamp method is unsuitable.

After dealing with the vascular pedicle the Cripps pad is removed, and any oozing surfaces on the diaphragm are picked up, underdrened by a snaking suture and tied off. Drainage is unnecessary.

Before the wound is closed and after complete haemostasis is assured, three pints of warm normal saline are poured into the abdominal cavity. This often gives the patient that extra little flip at a time when it is most needed. In cases of rupture of the spleen the blood in the peritoneal cavity can be clotted and used for autotransfusion but, so far, I have never had to resort to this measure.

4. *Closure of the wound.* The wound is closed in layers with strong catgut and three or four tension sutures are inserted to guard against the possibility of burst abdomen or postincisional hernia (Fig. 11). The tension sutures are placed through metal or mother-of-pearl buttons so as to prevent pressure or cutting of the skin.

## FROM THE CLINIC OF THE WOMAN'S HOSPITAL

DESTRUCTION OF THE URETHRA AND LOSS OF VESICAL CONTROL  
ASSOCIATED WITH VESICOVAGINAL FISTULA

## A TECHNIQUE FOR ITS CORRECTION

GEORGE GRAY WARD M.D. F.A.C.S., New York

IN 1923 I published the report of a case of reconstruction of the urethra after complete loss complicating an extensive vesicovaginal fistula (2). The technique employed was that suggested by Kelly of making a tunnel beneath the vestibule and drawing through it a flap dissected from the anterior vaginal wall with its base left attached to the vesical opening. During the discussion of this case before the American Gynecological Society Dr. Lillian Farrar made a valuable suggestion for improving this technique by dissecting a wider flap and converting it into a tube by sutures, thus forming a canal completely lined with mucosa for the new urethra which is then drawn through the tunnel made beneath the site of the original urethra. Since then Rawls, McGlinn (1) and several others have adopted this procedure with fair success.

The difficulties to be overcome in such cases with the associated loss of vesical control are very great and the conditions to be met with are rarely alike in any two instances consequently we must be prepared to improvise and change a given technique to suit the circumstances in each case. While we may succeed in forming a useful urethral canal, the greatest difficulty is to establish a satisfactory vesical control. The employment of a mattress stitch of linen placed at the site of the vesical sphincter and the internal meatus after Kelly's technique, and the buttressing of the neck of the bladder with buried catgut sutures is usually relied upon to obtain control, but as we all know success is not always complete or permanent.

On account of the variability of the conditions to be met with, when one has succeeded in procuring a satisfactory result, the means adopted may prove of help to others. I therefore report the following case and the technique employed.

Mrs. E. H., age 36 years, married 6 years, was referred to me with the history of having had one labor in September 1923, at full term. A difficult forceps delivery resulted in a dead baby, a vesicovaginal fistula, and loss of the urethra. She had been operated upon eight times during the past 4 years, all operations ending in failures. The last operation was in June, 1931.

I first saw her on June 6, 1932, and my examination showed a complete loss of the urethra with the exception of the external meatus, and a vesicovaginal fistula circular in shape and with a diameter of 1 centimeter situated in the trigone near the site of the internal meatus. On November 22, 1932, I operated as follows:

An incision was made on the anterior vaginal wall above the fistula outlining a quadrangular flap 2.5 centimeters wide and 3 centimeters long. This flap was dissected from the vaginal wall up to the fistula leaving it attached with the upper margins slanting obliquely to the superior border of the vesical defect. The flap was then formed into a tube by suturing the margins together after the technique suggested by Farrar (Fig. 1). A soft rubber catheter was then passed through this tube and into the bladder through the fistula. The site of the original urethra was then dissected out so as to form a deep U shaped groove and the newly constructed tube was laid in this groove and its end with the catheter was brought out of the external meatus, which had been previously denuded of mucosa, and sutured to it. The margins of the groove were then brought together over the urethral tube and sutured with interrupted sutures (Fig. 2). A Kelly mattress stitch of linen was then placed at the neck of the bladder for control and the edges of the vaginal denudation were united with interrupted sutures (Fig. 3).

The wound healed by primary union with a perfect restoration of the urethral canal and closure of the fistula. For a few days the patient had some control of the bladder but when on her feet the control was insufficient so that in the erect posture it was unsatisfactory. I found that slight pressure on the urethra completely stopped the flow of urine, and I succeeded in obtaining a perfectly satisfactory control by using a Thomas-Hodge pessary inserted in the *reverse* position. The exact amount of necessary pressure on the urethra was easily obtained by softening the pessary in boiling water and bending the bulbous end to the required angle (Fig. 4). The patient is perfectly dry and comfortable with the pessary ever since and she removes it for cleansing and replaces it herself whenever necessary.

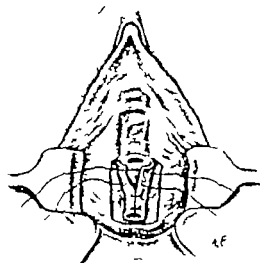


Fig. 1

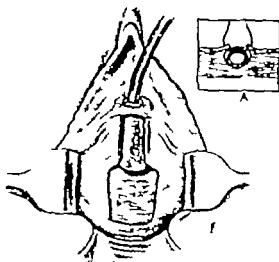


Fig. 2

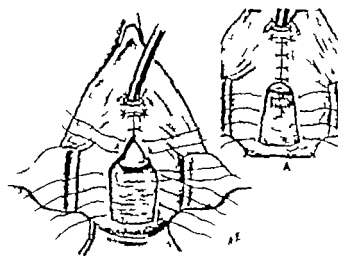


Fig. 3

In this case the formation of a groove or ditch in which to place the urethral tube proved a far more satisfactory technique than to make a tunnel posterior to the vestibule. The original site of the urethra in these cases is largely cicatricial tissue in most instances, and there is danger that the vaginal surface of the tunnel may slough out on account of an insufficient blood supply. I believe that the formation of a groove as a bed for the new urethra permits of a more perfect and more certain result than the tunnel operation.

Fig. 1. Reconstruction of the urethra. The dotted line shows the site of the destroyed urethra with the external meatus intact and a vesicovaginal fistula at the neck of the bladder. As suggested by Farrar the quadrangular flap dissected from the anterior vaginal wall and sutures passed to convert it into a tube. Note the upper margins of the flap end above the fistula.

Fig. 2. A catheter is passed through the tube and to the bladder, and the new canal is laid in a deep U shaped excavation that has been made at the site of the original urethra. See insert A.

Fig. 3. The end of the canal sutured to the external meatus, and the margins of the excitation brought together with sutures over the new urethra. A mattress suture (Kelly) is placed at the neck of the bladder. Insert A shows the mattress suture tied, and the sutures placed to close the vaginal demarcation.

The employment of some form of pessary to control the urine by pressure has been advocated by many writers, but the general opinion has been that it is an unsatisfactory method and difficult to apply. The use of a Thomas-Hodge pessary with its thick bar in the *reverse* position I have not seen suggested before, and as its employment and adjustment are so simple and proved to be so satisfactory in this case, I believe that it is worth a trial in endeavoring to give these unfortunate patients relief.

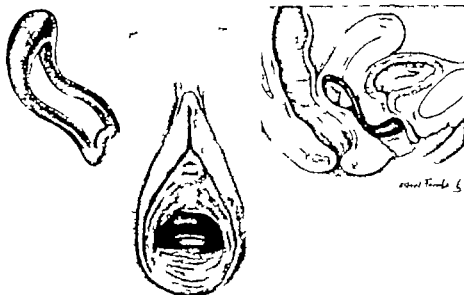


Fig. 4. Thomas-Hodge pessary placed in *reverse* position, the end having been bent to give the correct amount of pressure to insure vesical control.

Complete destruction of the urethra is a comparatively rare condition, yet McGlenn reports that seventeen articles on reconstruction of the female urethra have been published in the past 3½ years, and a number of successful results have been reported. In spite of the difficulties to be overcome in these cases, I believe that an attempt

to correct the condition should be made before resorting to the somewhat radical procedure of Coffey.

#### REFERENCES

1. MCGLENN. *Am. J. Obst. & Gynec.* 1933 xxiv 262
2. WARD. *Surg. Gynec. & Obst.* 1923 xxvii 678-682

## THE PELVIC OUTLET—ITS PRACTICAL APPLICATION

JOSHUA WILLIAM DAVIES, A.B. M.D. New York

From the Department of Anatomy, Columbia University Medical School and the Woman's Hospital, New York

TO comprehend the pelvic outlet correlation with an area more readily understood is a distinct advantage. Knowledge concerning the outlet removes a great degree of uncertainty and substitutes a feeling of confidence. The anterior abdominal wall is easily dissected and amply described in anatomical textbooks, so an attempt will be made to correlate the pelvic outlet with it the outlet being difficult to dissect and vaguely described in anatomical textbooks.

In order to facilitate a perception of the abdominal and pelvic walls, the layers of the abdominal wall will be reviewed and an attempt will be made to trace the corresponding layers to the inguinal region and to the pelvic outlet. Such a description should enable the operator to work on the pelvic outlet with the same confidence with which the abdominal wall is incised or repaired.

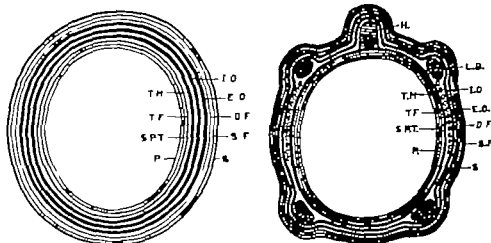
In an effort to avoid the confusion arising from the use of the several terms applied to the same structure an outline will be presented into which the readers own terms may be interpolated thereby facilitating the reading of the description without the addition of explanatory names throughout the text.

Gellaudet has shown that all voluntary muscle is covered by a distinct layer of supportive structure called fascia. On flat muscle this structure is

shaped like a sheet while on elongated muscle the fascia envelopes it as a sheath.

Involuntary muscle however due to its function of distensibility could not very well be covered by a distinct sheath the purpose of which is to maintain form. It is, therefore, covered by a layer of fibro-areolar tissue which contains varying quantities of fat elastic tissue and smooth muscle the purpose of the fat being to protect the viscus from pressure against resistant structure, and the involuntary muscular fibers to maintain the tone of the buffer layer. It is the author's belief that the involuntary muscular fibers hypertrophy and may take on the function of a supporting tissue when additional support is required. In a nullipara such as Goff describes, the structure may be quite negligible, yet with a multipara in which additional support is required, definite bands of hypertrophied tissue may be noted.

To facilitate a comprehension of the abdominal, thoracic, and pelvic layers, let us consider in Figure 1 that the chest, abdomen and pelvis are bounded by a layer of muscle which is covered by a distinct sheath of restraining tissue known as fascia. Superficial to the outer layer and deep to the inner layer of fascia is a layer of fibro-areolar tissue containing varying quantities of fat, elastic



FIGS. 1 and 2. S., Skin, S.F. superficial fascia, D.F., deep fascia, E.O. external oblique muscle, I.O. internal oblique muscle, T.M. transversus muscle, T.F., transversalis fascia, S.P.T. subperitoneal fibro-areolar tissue, P., peritoneum, L.B., limb box, H. head.

tissue, and smooth muscle. The outer layer is called the subcutaneous layer while the inner layer is called the subperitoneal fibro-areolar layer. Bounding the entire structure is a superficial protective layer the skin and an innermost protective layer the peritoneum.

The muscular layer, through a process of splitting in man becomes three layers each of which is covered by a distinct sheath of fascia. The superficial layer of muscle is called the external oblique the intermediate layer, the internal oblique while the innermost layer is called the transversus. The fascia applied to the external oblique muscle is naturally deep fascia and should be called external oblique fascia, just as the fascia covering the transversus abdominis muscle is called the transversalis fascia. The intermuscular layers, while not well developed in the abdominal wall, are very distinct in the pelvic outlet. This is due, perhaps, to the assumption of the erect posture, together with the absence of a tail, which by flexion would add additional support to the outlet.

In Figures 2 and 3 areas of osseous tissue will be seen superficial to the transversus muscle. The growth of the osseous tissue breaks the outer layers into individual muscles which are applied to the osseous projection, forming thereby the extremities, head, chest, and pelvis. In the chest, the layers are distinct and are called the external and internal intercostal muscles. One can readily remember the direction of these muscles because they correspond to the layers of the abdomen and as such have a similar direction the general direction of the external sheet being medially and distally while the middle sheet courses proximally and medially. Occasionally, one will see a thorax in which several ribs have fused and by like analogy the bony pelvis may be considered to be a fusion of five sacral ribs the gluteal muscles corresponding to the external oblique layer while the ileopsoas corresponds to the internal oblique layer. A continuation of the transversus abdominis forms the levator and a proximal medial offshoot carries with it the underlying layers and forms the diaphragm, which divides the thoracic and abdominal cavities.

In the perineum, Figure 3 the external oblique layer breaks into functioning strands of muscle, which have definite function and as such have been called the ischio-cavernosus, bulbocavernosus, superficial transverse perineal, and the superficial layer of the external anal sphincter muscles. The external oblique fascia covers and unites each individual muscle, although anatomical textbooks lead one to believe that Colles

layer lies adjacent to the muscle, rather than superficial to the fascia. This is perhaps due to a compensatory hypertrophy of the deep layer of the superficial fascia, which overshadows the thinned deep fascia covering muscles applied to erectile tissue.

The internal oblique muscle continues across the pelvic outlet as a distinct sheath it is however perforated by the anus vagina, and the urethra and as such acts as sphincters for these structures. The fascial coverings of this muscle have hypertrophied and are called the superficial and deep layers of the triangular ligament.

The fascia applied to the transversus muscle which in the pelvis is called the levator ani is the supra anal and infra anal fascia.

After a generalization which suggests a working plan for a more detailed study of the pelvic outlet, we are bewildered in our attempt because of the inaccessibility due to the overlying soft tissues and the hypertrophied tuberosity of the ischium together with the attachment of the gluteus maximus to the coccyx which places the musculo-fascial outlet at a confusing level bounded by ischio-rectal fossae. It may therefore be advisable

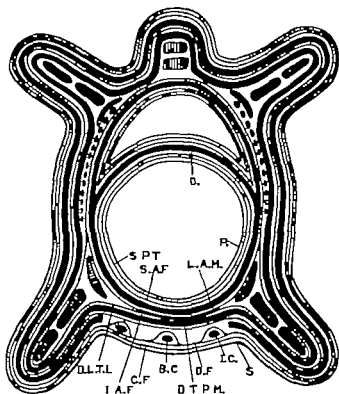


Fig. 3 D Diaphragm P., peritoneum, SPT, subperitoneal fibro-areolar layer S.A.F., supra anal fascia, L.A.M., levator ani, I.A.F. infra-anal fascia, D.L.T.L., deep layer triangular ligament, D.T.P.M., deep transverse perineal muscle B.C., bulbocavernosus muscle I.C. ischio-cavernosus muscle, D.F. deep fascia, C.F., Colles fascia.





Fig. 4. The superficial layers of the outlet.

to study first, the superficial layers of the outlet of a male such as Figure 4 and later the deeper layers of a female.

On the right, the skin and the superficial layer of superficial fascia have been removed, thus exposing the deep layer of the superficial fascia which is known as Colles layer. This layer is



Fig. 5. The deeper layers of the outlet.

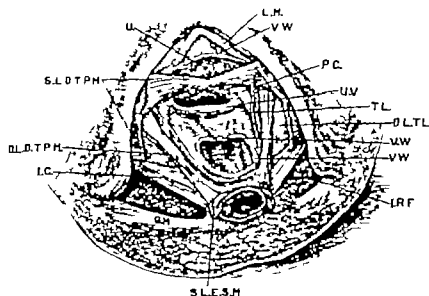


Fig. 6.

Fig. 6. L.M., Labia majora, I.I.I., vaginal wall, U, urethra, S.L.D.T.P.M., superficial layer deep transverse perineal muscle, D.L.D.T.P.M., deep layer deep transverse perineal muscle, G.M., glans clitoridis, F.C., perineococcygeus, U.V., urethrovaginal bundle of levator, T.L., triangular ligament, cut edge, D.L.T.L., deep layer triangular ligament, I.I.I., vaginal wall, L.R.F., ischioanal fossa, S.L.E.S.M., superficial layer external sphincter muscle.

seen to stretch across the arch of the pubic and ischial bones and to be intimately attached to the ram. Anteriorly it is continuous with the corresponding layer of Scarpa and on the scrotum, blends with the dartos. Posteriorly it fills in the ischio-rectal fossæ and then blends with the superficial fascia of the thigh. In the region of the transverse perineal muscle, it becomes adherent to the fascia covering this muscle, thereby forming a septum which prevents the extravasation of urine posteriorly, should the urethra be ruptured through the bulbocavernosus muscle and its fascia.

On the left, Colles' layer has been removed thereby exposing the deep fascia covering the superficial perineal muscles, which includes the superficial layer of the external anal sphincter. Lateral to the sphincter, the infra anal fascia is seen. (It represents the attenuated fascia of the external and internal oblique muscles, brought about by the concentration of the muscular layer to form the external sphincter, as well as the transversalis fascia, on the levator.) Yet the area is mystifying, however, by dividing the gluteus maximus (Fig. 5) from its attachment to the coccyx and the sacrum and later from the sacrotuberous ligament, a less confusing plane of the pelvic outlet is reached particularly if one realizes that the ischial tuberosity is merely an osseous hypertrophy due to traction by the hamstring muscles and consequently projects distal to the muscular outlet. The ischio-rectal fossæ by this procedure are shallow and it is noted that the so called free edge of the triangular ligament is merely an elevation of the external and internal oblique fasciæ as the vessels course medially, distally, and anteriorly to the perineal body from the internal pudendal vessels. Attention is called to the fact that the so called free border does not run transversely but follows a graceful curve, the convexity of which is directed anteriorly. The practical importance of this anatomical relationship will be stressed later.

The perineal portion of the external oblique fascia can now be traced laterally to the adductor muscles of the thigh posteriorly, to the anus and the gluteal muscles, anteriorly over the bulbous perineum to the external inguinal ring where in the male it becomes the external spermatic fascia covering the cord. Medial to the external inguinal rings it is continuous with the fascia of the external oblique muscle. Lateral to the anus it becomes continuous with the infra anal fascia.

The removal of the deep fascia reveals the superficial layer of muscles composed of the cremaster, bulbocavernosus ischio-cavernosus, su-

perficial transverse perineal, and the superficial layer of the external sphincter of the anus. In the female the structures are identical, with the exception that the bulb is perforated by the vagina, which divides it into two lateral bulbæ, communicating anteriorly.

In the female (Fig. 6), the deep fascia (external oblique) and the superficial muscles, including the bulb, have been removed, as well as the superficial layer of the triangular ligament (internal oblique fascia) which exposes the deep transverse perineal muscle, the superficial fibers of which have been divided lateral to the vagina and reflected anteriorly. While this subject is exceptionally well developed and presents muscle bands which are not as readily noted in the average subject, it is used to facilitate a comprehension of the pelvic outlet and at the same time emphasize the importance of intelligent development and preservation of these muscles.

The deep transverse perineal muscle is at times composed of two strata. The fibers of the superficial layer encircling the urethra are called the external voluntary urethral sphincter, while those applied to the vagina act as a vaginal sphincter. The deep layer is principally applied to the anus, some of its fibers passing anterior to the anus to fuse with those of the opposite side, while others encircle the anus to form the deep layer of the external sphincter of the anus. Those passing anterior to the anus to fuse with those of the opposite side, act as an accessory sphincter of the vagina.

Deep to the deep transverse perineal muscle, the deep layer of the triangular ligament can be seen. It is perforated by the vagina. Posterior to the vagina, it enters into the formation of the perineal body and from there is continued posteriorly as the fascia covering the deep layer of the external sphincter of the anus. Anterior to the vagina it has been removed to expose a deeper plane of the urethrovaginal region, containing the pubococcygeal bundles of the levator. In this specimen, a very distinct bundle of muscle stretches transversely from the levator between the urethra and vagina, which acts as an accessory urethral sphincter. In other specimens, the bundle of muscle is poorly developed and may be replaced by a thin layer of fascia which represents the fusion of the superior and inferior fascial layers of the levator in the midline anterior to the vagina. This structure acts as an accessory sphincter of the urethra the efficiency of which is increased by the ease with which the thin yielding urethra is compressed against the solid pubic bone. Lateral to the vagina, the pubococcygeal

bundle reinforces the attenuated ileococcygeus and sends a few fibers into the vagina and into the posterior perineal body.

The fascia covering both surfaces of the levator runs to the midline posterior to the vagina and becomes a component part of the perineal body and as such is involved in perineal lacerations. On the lateral and posterior walls of the anus the levator inserts between the external voluntary and the internal involuntary sphincters. It acts as an accessory voluntary sphincter both by compressing the rectum and by angulating it anteriorly.

To recapitulate, the three muscular layers together with their fascial covering are perforated by the urethra, the vagina, and the rectum. In many subjects, the muscles are poorly developed and the fascia of a flaccid quality not unlike the structures composing a flaccid abdominal wall. Such structures, if unlacerated are further relaxed by distention thereby decreasing their function.

Let us turn to the rigid outlet of the pelvis, which is roughly diamond shaped. It is bounded anteriorly by the body of the pubic bone, and the arch of the pubic and ischial bones. Posteriorly it is bounded by the sacrotuberous ligaments and the sacrum. The area is lessened by the extension of the coccyx anteriorly from the sacrum but it like the soft structures, may be broken and damaged as the head is forced through the rigid outlet thereby permitting delivery of the child but with what damages to the mother?

Before considering such damages, let us direct our attention to the sacrotuberous ligament (Fig. 5) which stretches from the lateral border of the sacrum to the tuberosity of the ischium. The sacral extremity of the ligament is proximal and medial to the ischial extremity. A descending occiput posterior is deflected into the oblique diameter by the promontory of the sacrum and on striking the sacrotuberous ligament, the oblique occiput will meet less resistance by rotating anteriorly. By rotation it exerts pressure against the spine of the ischium, which might account for the characteristic low back pain of an occiput posterior. The presenting part of an oblique occiput anterior is anterior to the ischial spine and consequently rotates less painfully on the inclined plane of the ischium. One will note that a wide sacrum and a narrow interschial diameter will predispose to a persistent posterior position, due to the lessened resistance against an oblique head which rotates posteriorly.

Granting that the head passes the rigid outlet, nature has provided the hormone relaxin, which

increases the elasticity of the soft parts, so that in retracting over the passing child undue lacerations do not result. The quantity of the hormone seems to diminish as the later years of child bearing approach. Then again there is the character of the tissue itself some tissue is sclerotic and refuses to dilate, while another tissue will relax so completely that it fails to involute.

In an effort to raise the standard of the pelvic outlet in a *nullipara* let us consider the possible damages to the musculofascial layers and other structures and so direct our effort to prevent or minimize such injuries. The following may possibly be damaged (1) gluteus maximus, (2) coccyx, (3) coccygeus muscle, (4) pudendal vessels, (5) deep transverse perineal muscle and triangular ligament (6) posterior perineal body (7) vagina (8) anterior perineal body (9) levator ani (10) para vaginal fibro-areolar tissue, (11) bladder and paravascular fibro-areolar tissue, (12) rectum and pararectal fibro-areolar tissue.

*Gluteus maximus* Turning to Figure 5 we observe the attachment of the gluteus maximus to the side of the coccyx. In a narrow outlet, especially if the coccyx is displaced, it is possible to injure one or the other of the glutei while not a serious injury it may be a factor in the annoying low spinal discomfort of the mother. Flexion of the thighs increases the tension of the glutei thereby narrowing the posterior outlet while extension of the thighs relaxes the glutei. Undue extension, however narrows the bony outlet. A position therefore between extension and flexion is to be preferred.

*Coccyx* The importance of the coccyx cannot be overstressed, particularly since it serves as an attachment for the glutei, the levators, coccygei, and the external sphincters of the anus. Protection from damage is afforded by the neutral position referred to for the protection of the glutei. The absence of a regulated anesthetic predisposes to such damage.

*Coccygeus muscle and the sacrospinous ligament.* One or the other or both of these may be torn from their insertion into the coccyx, as the coccyx is displaced posteriorly particularly in a precipitate delivery or during an uncontrolled anesthesia. Undue flexion of the thighs increases the tension on these muscles and ligaments. A well placed perineotomy and a neutral position tend to prevent such damage.

*Pudendal vessels* In Figure 5, the pudendal vessels are shown leaving Alcock's canal of the obturator fascia, to course anteriorly medially and distally to the posterior perineal body. Such a course elevates the deep fascia of the musculo-

## CORRESPONDING LAYERS OF ABDOMINAL WALL AND PELVIC OUTLET

Chest	Abdomen	Scrotum	Pelvic outlet	Anus "
Skin	Skin	Skin	Skin	Skin
Subcutaneous layer	Camper's layer	Dartos	Cruveilhier's layer	Corrugator cutis ani
	Scarpa's layer		Colles' layer	
<i>Fascia</i> external intercostal	<i>Fascia</i> external oblique	<i>Fascia</i> external spermatic	<i>Fascia</i> superficial perineal	<i>Fascia</i> superficial layer external sphincter
<i>Muscle</i> external intercostal	<i>Muscle</i> external oblique		<i>Muscle</i> superficial perineal	<i>Muscle</i> superficial layer external sphincter and
<i>Fascia</i> external intercostal	<i>Fascia</i> external oblique		<i>Fascia</i> superficial perineal	<i>Fascia</i> superficial layer external sphincter
<i>Fascia</i> internal intercostal	<i>Fascia</i> internal oblique		<i>Fascia</i> superficial layer triangular ligament	<i>Fascia</i> deep layer external sphincter
<i>Muscle</i> internal intercostal	<i>Muscle</i> internal oblique	<i>Muscle</i> cremasteric (middle spermatic)	<i>Muscle</i> deep transverse perineal	<i>Muscle</i> deep layer external sphincter and
<i>Fascia</i> internal intercostal	<i>Fascia</i> internal oblique		<i>Fascia</i> deep layer triangular ligament	<i>Fascia</i> deep layer external sphincter
<i>Fascia</i> transversus thoracis	<i>Fascia</i> transversus abdominis		<i>Fascia</i> infra-anal	<i>Fascia</i> infra-anal
<i>Muscle</i> transversus thoracis	<i>Muscle</i> transversus abdominis		<i>Muscle</i> levator ani	<i>Muscle</i> levator ani
<i>Fascia</i> transversalis	<i>Fascia</i> transversalis	<i>Fascia</i> internal spermatic	<i>Fascia</i> supra-anal	<i>Fascia</i> supra-anal
Subperiosteal layer	Subperitoneal layer	Subperitoneal (innermost spermatic)	Subperitoneal (fascia endopelvicina)	
Plasma	Peritoneum	Vaginal process	Peritoneum	

fascial outlet and forms the so called free border of the triangular ligament. Within this fold is contained the superficial transverse perineal muscle it is, however not always present. Your attention is called to the crescent, rather than transverse, shape of this ridge.

Unless the position of the perineal body is deliberately localized it is usually placed too far posteriorly. Figure 5 places it in the interschial diameter which is the diameter through which the biparietal diameter of the fetal head must pass. This means that to permit delivery of the head anterior to the biparietal diameter of the child the perineal body must be displaced considerably posterior to its normal position. Should the pudendal vessels to the bulb run transversely, they would be torn by such a change, unless they were sufficiently tortuous to permit such extension. Nature, however, has provided for this displacement of the perineal body, by so placing the vessels that posterior displacement of the perineal body relaxes rather than increases their tension.

*Triangular ligament and deep transverse perineal muscle.* The vaginal passage is much larger at its proximal end than at its distal end. An addi-

tional factor in narrowing it, is the various layers of the muscular outlet which it must penetrate. The opening of the vagina is so disguised by the labia and superficial tissue, that it is difficult to visualize. However it may be compared to the opening of an umbilical hernia which perforates the muscular and fascial coverings of the anterior abdominal wall. The vagina likewise perforates the levator ani the deep transverse and superficial perineal muscles and their fascial coverings. The urethra and the anus likewise perforate the musculofascial sheets. The septum which divides the anus from the vagina is called the posterior perineal body. Anteriorly between the vagina and the urethra is a similar septum, called the anterior perineal body.

Delivery of the head forces the vagina to the lateral walls of the pubic arch so that injuries to the musculofascial outlet may be many and varied. Attention, however is directed to undue relaxation of the outlet which, because of the erect posture, is very bothersome also to injuries of the anterior and posterior perineal bodies which will be discussed individually because of their great importance and frequency of injury.

**Posterior perineal body.** One readily perceives how easily overdistention by a descending head may break into the anterior and posterior perforations of the perineum. In Figure 6 as the deep layer of the transverse perineal muscle is forced laterally by the delivering head, laceration may occur in many places should the laceration be in the midline, the sphincter will be involved. So it may be advisable to consider the external sphincter with injuries to the posterior perineal body particularly in those individuals in whom the connection between the deep transverse perineal and the deep layer of the external sphincter is maintained. In other subjects the external sphincter has no muscular connection with the perineal body yet the continuity of the fascia cannot be denied. It is to this latter group that the classification first, second, and third degree lacerations of the sphincter have been applied. The anatomical continuity of the deep layer of the external sphincter with the deep transverse perineal muscle, predisposes to injury of the deep sphincter fibers such a laceration is unnoticed unless it is sufficient to involve the superficial layer of sphincter muscle, which is derived from the superficial muscle sheet which has broken into five individual perineal muscles.

**Vagina.** The truncated shape of the vagina predisposes to lacerations or relaxation of the distal portion. Ironing out merely predisposes to subsequent relaxation, while a properly placed incision may regulate a laceration. Such an incision is not made laterally because of trouble some hemorrhage from the vaginal plexus contained within the lateral ligament of the vagina. It is not made anteriorly because of the narrow septum and defective exposure for repair. It is much easier posteriorly as the perineum is distended but to extend the incision on to the posterior wall of the vagina, the distention should not be too great and unless the extension is carried on to the posterior wall, the distal opening of the vagina will not be enlarged. Such a procedure should prevent undue stretching of the vaginal wall and facilitate involution. At the same time it shortens the vagina and regulates lacerations by confining them to an area which is readily exposed and repaired. Prolonged distention is prevented by delivery with low forceps.

**Anterior perineal body.** Descent of the head conspicuously everts the anterior wall of the vagina and if held back by a resistant musculo-fascial outlet, that portion of the deep transverse perineal muscle which passes between the urethra and the vagina, will become overstretched and if improperly involutioned, will greatly decrease the

function of these fibers which are known as the voluntary urethral sphincter. Improper relaxation predisposes to a laceration of this structure, which may be hidden by the unlacerated vaginal mucous membrane. Protection is afforded both to overstretching and laceration by increasing the outlet with a properly placed incision (Fig. 6) and low forcep delivery.

**Levator ani.** Other than in a small area anterior to the urethra, the levator or its fascia runs to the midline of the pelvic outlet from the pubic bone to the coccyx. Its fibers are perforated by the urethra, the vagina and the rectum. The pubococcygeal muscle is the term applied to the most medial fibers, which have a bony origin and seem to strengthen the thin levator sheet. From the pubococcygeus, fibers run to the midline anterior to the vagina, posterior to the vagina, and posterior to the rectum. In Figure 6 let us suppose that the coccyx is displaced posteriorly to perineal delivery: such a displacement tightens the pubococcygeus and therefore draws the bundles closer to the midline, thereby predisposing to tearing.

In the case of a rigid outlet which requires considerable anteroposterior molding, the occiput more nearly fills in the arch of the pubis and as such forces the two anterior extremities of the pubococcygeus further apart with the result that the urethrovaginal bundle of the levator is stretched or lacerated. Attention is drawn to the fact that this muscle, while not present in all specimens, is replaced by fascia composed of supra-anal and infra-anal fascia which runs to the midline. To lessen the time that the head rests on the pelvic floor by a properly placed incision and low forcep delivery is important in the prevention of such an injury. Posterior to the vagina, the supra anal and infra anal fascia and the few fibers from the levator are involved by lacerations of the posterior pelvic floor. To control the laceration and at the same time be able to repair the division is of great importance. Those fibers ending in the anococcygeal raphe may be torn from the raphe or even the side of the coccyx by imperfect anaesthesia. Such an injury cannot be detected, due to the overlying tissues.

**Paravaginal fibre-areolar tissue.** While not a very dense structure it is thinned by the distention of the vagina during delivery and is certainly of less efficiency when the lateral ligament of the vagina is relaxed by a lacerated perineal body.

**Bladder and paraovarial connective tissue.** The eversion of the anterior wall of the vagina is much more conspicuous than the eversion of the posterior vaginal wall, particularly as the anterior perineal body is reached however the distention

of the anterior vaginal wall and the underlying structures, either overdistends or lacerates the so called pubocervical ligament (a thickening of the subperitoneal fibro-areolar tissue stretching from the cervix to the urethra, which it encircles and then passes to the back of the pubis) Prolonged overstretching is relieved by relaxing the vaginal wall by means of a properly placed incision in the wall of the vagina which permits a more rapid delivery with low forceps.

*Rectum and pararectal connective tissue* Prolonged distention of the posterior wall of the vagina may result in laceration or relaxation of the posterior vaginal wall and also the surrounding paravaginal and pararectal connective tissue.

In a previous publication the author has shown the existence of a thickening of the subperitoneal fibro-areolar layer which stretches from the anterior surface of the rectum to the posterior wall of the vagina. This structure contains branches of the middle hæmorrhoidal artery which supplies the posterior wall of the vagina. It tends to prevent anterior displacement of the posterior wall of the vagina. Laceration or stretching of the posterior wall of the vagina injures this structure, which is comparable to the pubocervical ligament, and thereby permits an anterior displacement of the lower fourth of the vaginal wall to take place.

#### CONCLUSIONS

The following suggestions for the relief of possible injuries to the musculofascial layers is preventive gynecology, however, unless the operator is well trained and is working in a well equipped hospital with a full operating staff the procedure is to be condemned rather than to be recommended.

As we realize that the vagina narrows toward its outlet, it is our desire to increase the volume of the distal portion of the vaginal anal canal if we wish to avoid injuries resulting from overdistention. Anaesthesia facilitates relaxation and when satisfactorily administered permits a regulated delivery but in subelastic tissue anaesthesia alone is not sufficient. An incision of the wall of the vagina, which extends at least to the junction of the lower and middle thirds, increases the volume of the distal third and at the same time shortens the length of the vaginal tube through which the fetus must pass. The vagina however is further narrowed by the musculofascial layers of the pelvic outlet which must be incised in our attempt to prevent overdistention or uncontrolled laceration.

An incision of the outlet and the vagina cannot be made anteriorly because of the narrow anterior perineal body, which if incised would injure the urethra and because of incomplete exposure would make repair difficult. Lateral to the vagina an incision would involve the vascular structures composing the lateral ligament which when unintentionally lacerated causes troublesome hæmorrhage.

A midline incision posteriorly will divide the shelving posterior perineal body and distinctly enlarge the pelvic outlet. Such an incision, however, predisposes to a laceration of the anal sphincter because of its continuity with the perineal body. Some obstetricians have endeavored to avoid extension into the anal sphincter by incising the perineal body in the midline as far as the sphincter and then continuing laterally and posteriorly so that the extension will be continued into the ischio-rectal fossa instead of the sphincter. This procedure, while avoiding extension into the rectum may divide levator fibers attaching to the side of the rectum, which will more than likely be neglected in the repair because of the inaccessibility of these fibers. A midline incision is recommended, at most as far as the circular fibers of the anal sphincter. If more room is required it is advisable to remove the forceps as soon as the infant's chin can be held with a hand placed posterior to the anus and delivery effected, if need be, by careful pressure from above.

It is desirable to make the incision before the head has overdistended the outlet. Two clamps placed lateral to the midline at the junction of the vagina and the pelvic floor, namely on the hymen, will insure an incision through the musculofascial outlet and also the posterior wall of the vagina. The incision is carried carefully as far as the circular fibers of the anal sphincter and then the short incision on the posterior wall is continued proximally to the junction of the lower and middle thirds of the vagina. Such a procedure will relax and appreciably shorten the distal third of the vagina and enlarge the musculofascial outlet. It therefore aids in lessening overdistention and regulates lacerations which may have occurred under normal circumstances.

This study was prompted by the observation of the perineal outlets of several thousand multiparae which while considered normal, differed greatly from the outlets before delivery. It is hoped that this study will help to increase our understanding of this region and eventually help to give our patients more normal appearing pelvic outlets.

## SUMMARY

1 Voluntary muscle is covered by a distinct restraining structure called fascia while involuntary muscle due to its function of distensibility is covered by a layer of fibro-areolar tissue which contains varying quantities of fat smooth muscle, and elastic tissue.

2 When childbirth damages the normal supports, the fibrous and smooth muscle constituents of the subperitoneal layer hypertrophy and form definite strands of supporting tissue.

3 Fascial continuity is maintained while muscle sheets may break into smaller functioning bundles.

4 The assumption of the erect posture and the absence of a tail are factors which bring about hypertrophy of the intermuscular fasciae of the pelvic outlet.

5 The superficial perineal muscles and their fascial covering including the superficial layer of the external sphincter of the anus, are comparable to the external oblique muscle and its fascia.

6 The deep transverse perineal muscle and its fascial coverings, the superficial and deep layers of the triangular ligament together with the deep layer of the external sphincter of the anus are comparable to the internal oblique muscle and its fasciae.

7 The levator and its supra anal and infra anal fasciae are comparable to the transversus abdominis and its fascial coverings.

8 The three muscular layers of the pelvic outlet are perforated by the urethra, the vagina and the rectum.

9. In the perineum the fascia covering muscle applied to erectile tissue is necessarily attenuated. To compensate, the deep layer of the subcutaneous tissue, known as Colles fascia, is hypertrophied.

10. Colles layer lines the ischio-rectal fossae.

11 That portion of the levator which lies between the perforating urethra and the vagina

forms a part of the anterior perineal body and as such acts as an accessory urethral sphincter. It is frequently damaged by the passage of the head through the pelvic outlet.

12 A relatively wide sacrum favors persistent occipitoposterior presentations.

13 Overdistention of the distal one third of the vagina may lacerate or prevent subsequent involution of the vagina and its fibro-areolar covering as well as the fibro-areolar covering of the bladder and the rectum.

14 The posterior perineal body lies in the transverse diameter of the outlet. It must be displaced posteriorly to permit the delivery of that part of the fetal head, anterior to the biparietal diameter.

15 The pudendal vessels are relaxed by the posterior displacement of the posterior perineal body.

16 Lacerations of the outlet may be multiple and oftentimes unrecognized.

17 The pelvis may be considered to be the fusion of five sacral ribs, the glutei being comparable to the external oblique muscle while the ileopsoas and the obturator are comparable to the internal oblique layer.

18 The so called free edge of the triangular ligament does not run transversely but follows a graceful curve, the convexity of which is directed anteriorly.

19. In measuring the pelvic outlet, the coccyx is disregarded because it may be displaced posteriorly to permit delivery but with what injury to the muscles, ligaments, and fasciae attached to it?

## REFERENCES

- DAVIES, JOSHUA WILLIAM. Abdominal and pelvic fasciae with surgical applications. Surg. Gynec. & Obst., 1932. LV 405-504.
- 2 GALLAUDET, B. B. The Planes of Fascia. New York: Columbia Univ. Press, 1931.
- 3 GORT, BYRON H. An histological study of the per vaginal fascia in a multipara. Surg. Gynec. & Obst. 93: III, 32-42.

## ADENOMATOUS POLYPI OF THE STOMACH

WITH SPECIAL REFERENCE TO MALIGNANT DEGENERATION<sup>1</sup>

EDWARD B. BENEDICT, M.D. AND ARTHUR W. ALLEN, M.D. F.A.C.S., BOSTON

MANY papers have been written on benign tumors of the stomach, but much confusion still exists as to how often such tumors become malignant. Menetrier in 1888 was probably the first to show that adenomatous polyps may undergo carcinomatous change. Stewart found that 28 per cent of polypi of the stomach were associated with carcinoma, but only 4.9 per cent of carcinomata were associated with polypi. Evidence obtained at autopsy is not conclusive, for polypi and carcinoma may perhaps occur independently in the same stomach or if carcinoma has developed from a polyp all trace of the original polyp may have disappeared in the cancer. Brunn and Pearl, in a study of 84 collected cases, each showing three or more gastric polyps, found an incidence of only 12 per cent malignant degeneration. Meyer and Brans state that malignancy occurs in 60 per cent of cases of gastric polypi, but give no evidence to substantiate this figure. Miller Ehasen, and Wright after searching extensively in many microscopic sections taken from adenomatous polypi, found carcinomatous change in 8 of 23 cases, or an incidence of 35 per cent. This is probably the most reliable figure to be found in the literature.

There are at the Massachusetts General Hospital clinical records of 17 cases of gastric polypi which have given symptoms severe enough to warrant surgical intervention. There are also records of 19 cases of gastric polypi in which the polyps were not suspected clinically but were found incidentally at autopsy. It is not possible to understand from the number, size, location, or pathology of the lesions why some have given symptoms and others have not though in general it may be stated that the more numerous and the larger the lesions and the nearer they are located to the pylorus, the more likely they are to give symptoms. There was no suspicion of malignancy in the microscopic appearance of the polyps found incidentally at autopsy. By a follow up study of the cases in which operation was done and a careful pathological review of specimens removed at operation, we believe the following 7 cases of adenomatous gastric polyps show evidence of malignant degeneration. This gives an incidence of malignancy of 41.2 per cent in polyps of the stomach which have caused severe symptoms.

E. I., M. G. H. No. 336193 male, aged 73 years, entered the hospital April 15, 1920, complaining of weakness and loss of weight of a year's duration. There had been no epigastric pain, nausea, vomiting, gas, anorexia, hematemesis, or melena. A definite non tender mass was palpable in the epigastrium. Gastric analysis showed no free hydrochloric acid in the stomach. Gastro-intestinal X ray showed a filling defect in the stomach which was thought to be a benign polyp. Operation was performed by Dr. Beth Vincent, who found a soft, rounded mass within the stomach, smaller than a tennis ball, attached to the anterior wall near the greater curvature. It appeared to be a polypoid growth and was removed with the cautery. Pathological report by Dr. T. B. Mallory and Dr. H. F. Hartwell was as follows: "Gross: A soft purplish red tumor measuring 3.5 by 4 by 5 centimeters. Its surface is rough and granular and it has a soft, narrow attachment to the underlying mucous membrane of the stomach. Microscopic examination shows elongated gland tubules which are frequently branching and are lined by a single layer of high columnar epithelium." Although some areas were atypical and showed mitotic figures, the tumor was considered a benign adenoma. Eight years later however this patient began to suffer from indigestion and vomiting, became emaciated and died after an illness of about a year. Shortly before death he was seen by his physician, Dr. Ray T. McDonald, of Medford, who found a definite mass in the epigastrium and felt very certain clinically of the diagnosis of carcinoma of the stomach.

No operation was performed during the final illness, and there was no autopsy hence the final diagnosis could not be confirmed by pathological examination. Although 9 years seems a long time, it is still quite possible that death took place from the development of malignant changes in atypical adenomatous cells not destroyed by the cautery or removed with the polypoid mass.

W. H. F. M. G. H. No. 87150 male, aged 55 years, entered the hospital November 4, 1917 complaining of intermittent diarrhea of 19 months' duration. There was no pain, griping, discomfort, nausea, vomiting or indigestion. There were no other symptoms except weakness and loss of 15 pounds in weight. Barium enema was negative. Gastro-intestinal X ray examination showed a filling defect 2.5 centimeters from the pylorus, which was interpreted as due to an extensive polypoid growth involving the antrum of the stomach. Gastric analysis showed no free hydrochloric acid. Operation was performed by Dr. R. H. Miller on January 9, 1918. The antrum of the stomach for about 3 inches up from the pylorus was filled with a soft, movable tumor which slipped around inside and seemed to fill the lumen. Besides this there was an area of hard nodular growth on the greater curvature about 4 inches from the pylorus. Behind the lesser peritoneal cavity in the region of the pancreas and coeliac axis, there was a firm, hard, adherent nodular mass of carcinoma. Radical operation was not possible but it seemed that the



patient might be helped if the growth inside the stomach could be removed. The stomach was therefore opened and an irregular soft, polypoid growth was removed. Pathological examination by Dr T B Mallory and Dr H F Hartwell showed a soft lobulated tumor about the size of a billiard ball. The pedicle was soft and broad. Microscopic examination showed a papillary growth with a complicated adenomatous structure. In some areas the tumor looked like a benign polyp, but in other areas there were atypical columnar epithelial cells in multiple layers, many cells containing mitotic figures. The appearance was consistent with that of a polyp which had become malignant. Four months later this patient died of cancer completely obstructing the oesophagus.

This case illustrates the simultaneous occurrence of a malignant adenomatous polyp and a carcinoma of the stomach. The carcinoma may have arisen from a similar malignant adenoma or may have arisen independently. The microscopic appearance of the polyp indicates that it probably would have become an adenocarcinoma.

J Z M G H No. 174643, male, aged 50 years, entered the hospital February 13, 1916 complaining of vomiting attacks of 4 years duration. The attacks occurred usually after eating or drinking anything cold. For about 3 years there had been almost constant gnawing pains around the umbilicus. Loss of strength had been marked for 3 months, and there had been a loss of 38 pounds in weight in the past 4 years. Gastro-intestinal X-ray films showed a mottled irregular filling defect involving the mid-portion of the stomach. The walls of the stomach in this region were rigid and peristalsis was absent. The findings were thought to be due to malignant disease. Operation was performed by Dr Beth Vincent. The stomach contained a globular tumor a little larger than a tennis ball, attached by a pedicle 3 centimeters in diameter at about the middle of the greater curvature of the stomach. The growth with its pedicle and a margin of apparently normal gastric mucous membrane was removed. Pathological examination by Dr T B Mallory and Dr H F Hartwell showed an area of stomach containing a soft, freely movable polypoid growth measuring 3 by 4 by 10 centimeters attached to the mucous surface by a broad base. Microscopic examination showed a branching papillary growth composed of closely set, irregular gland tubules, most of which were lined with normal epithelium, but some of which were formed by atypical cells in several layers with occasional mitotic figures. The growth was considered on the border line although not invasive as yet, at least potentially malignant. It might well be classified as carcinoma *in situ* (Broders). This patient was seen recently in our gastro-intestinal clinic. It is about 7 years since his operation and he is entirely symptom free.

From the microscopic appearance of this polypoid tumor it seems very probable that had it not been completely removed it would eventually have undergone further changes and become definitely malignant.

J J O M G H No. 318371, male, aged 57 years, entered the hospital December 30, 1931 complaining of weakness, dyspepsia, and palor of 2 years' duration. There had been occasional gnawing pains in the stomach, most marked 1 to 2 hours after meals, disappearing before the next meal. Food or soda for relief had not been tried. There had been a loss of about 90 pounds in weight in the

past 3 years. Gastro-intestinal X-ray films showed a polypoid mass at the junction of the upper and middle thirds of the stomach. Gastric analysis showed no free hydrochloric acid. Operation was performed by Dr Lincoln Davis on January 5, 1932. The stomach was found to contain a soft tumor the size of a small apple, at about the junction of the upper and middle third. Partial gastrectomy was performed. Three days later the patient died, necropsy showing general peritonitis and multiple pulmonary infarcts. Pathological examination of the stomach by Dr J I Bradley and Dr L E. Hummel showed a broad based polypoid mass, 5.5 centimeters in diameter and 3.5 centimeters in thickness. The surface was irregular, necrotic, and composed of multiple small projecting polypoid masses of tissue. At one margin the growth was lower slightly firm, and appeared to be more firm. Six centimeters away was another smaller but similar polypoid mass 3 by 3 centimeters. Microscopic examination showed adenomatous polyp with marked atypical proliferation; in some areas the atypicity was so marked as to justify the diagnosis of adenocarcinoma.

The pathological description in this case seems to indicate adenocarcinoma arising from an adenomatous polyp.

J F L, M G H No. 391246, male, aged 49 years, entered the hospital May 16, 1935, because of epigastric pain of 14 years duration, usually worse after meals. There had been no nausea or vomiting, but a loss of 20 pounds in weight in the past 3 weeks. Gastro-intestinal X-ray films showed large filling defects on the posterior wall of the stomach at the mid-portion and cardiac end, these were interpreted as due to inoperable carcinoma. Gastric analysis showed no free hydrochloric acid. The Hinton test was strongly positive on two occasions, but syphilis of the stomach was considered unlikely. A swinging temperature, which varied from 98 to 104 degrees during the month's stay in the hospital, was finally explained by a positive streptococcus viridans blood culture. On the thirty-third day in the hospital, after gradually becoming weaker and irrational, the patient died. Autopsy report by Dr T B Mallory describes the stomach as follows. Gross. Occupying the entire cardiac portion of the stomach but not involving the cardiac sphincter or the lower portion of the oesophagus is a large deeply ulcerated and perforated tumor mass with borders, in part polypoid and in part markedly nodulated. The crater measures nearly 7 centimeters in diameter and the total diameter of the growth is approximately 8 centimeters. Quite separate from this is a group of soft polypoid masses in the middle of the greater curvature about 8 centimeters from the pylorus. These show no induration and suggest benign polyps in appearance. Microscopic. Sections from the ulcerated tumor in the cardiac area show a fairly differentiated adenocarcinoma infiltrating the muscularis widely beyond the limits of mucosal involvement. Sections from the polypoid tumor show a much higher grade of differentiation. Many of the tubules approach the normal fully closely except for their great length. Near the base the tubules are less typical and show areas which are definitely carcinomatous with invasion of the muscularis. The inference that two carcinomas have developed from benign polyps is strongly suggested.

The autopsy findings seem to point to carcinomatous degeneration of two polypoid tumors.

B R P, M G H No. 350549, male, aged 47 years, entered the hospital August 29, 1916, complaining of

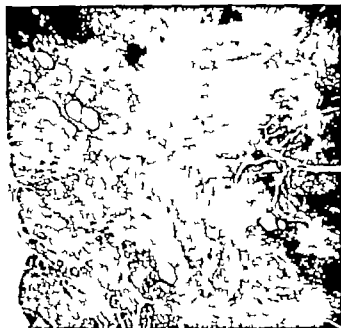


Fig. 1 Case B R. P., 1917 Low power showing simple adenomatous structure in some areas, malignant degeneration in others.

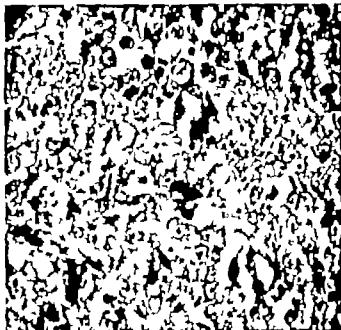


Fig. 2 Case B R. P., 1917 High power, showing malignant structure of certain areas shown in Figure 1

weakness, belching of gas, and abdominal discomfort after meals of 6 months' duration. There had been no nausea or vomiting. There had been a loss of about 15 pounds in weight. Physical examination was essentially negative, except for pallor and an indefinite mass in the epigastrium. Gastro-intestinal X ray films showed a small 6 hour residue and a large mottled filling defect of the medial portion of the stomach. This mass inside the stomach was movable and was thought to be a polypoid tumor or a half ball. The red count was 3.4 million and the haemoglobin 40 per cent on admission. The red cells showed moderate variation in size and considerable variation in shape, with marked achromia. The blood picture was considered to be that of secondary anemia. Examination of the stool on admission showed a slightly positive guaiac reaction. Gastric analysis showed no free hydrochloric acid, and the guaiac reaction was very faintly positive on the stomach contents. A second gastro-intestinal X ray examination a week after the first one confirmed the previous findings. Halfball of the stomach was considered unlikely, and the diagnosis was thought to be a polypoid tumor in the medial portion of the stomach. It was suspected that this might very well be malignant. Operation was advised but the patient refused to be operated upon, and was therefore discharged against advice with the diagnosis of question of carcinoma of the stomach and secondary anemia.

Second admission, July 10, 1917. Since discharge 10 months before, the patient had had attacks of pain around the umbilicus, radiating to the back and at times followed by vomiting. Several times there had been moderate hematemesis. There had been a still further loss of weight and strength. The pain was almost immediately relieved by food or soda and sometimes by vomiting. The red count at this entry was 1.5 million and the haemoglobin 20 per cent. Microscopic blood was present in the stools on two of six examinations. Gastro-intestinal X ray examination was again performed and showed a large filling defect of the medial and lower part of the stomach, suggesting a large globular growth which was most extensive on the posterior wall and the greater curvature. There was no

status. The X ray department made a diagnosis of an extensive pathological process in the stomach, probably malignant. Operation was performed by Dr C. A. Porter on July 10. When the abdomen was opened there was found no evidence of carcinoma. Palpation of the stomach showed five polypoid masses. The stomach was opened and a definite group of polypi enlarged to the size of a lemon was revealed. These growths were arising from two broad irregular pedicles on the posterior wall. The pedicles were clamped at the base and the tumors removed, following which the patient made an uneventful recovery. Pathological report by Dr T. B. Mallory and Dr H. F. Hart well showed a very atypical type of polypoid tumor showing in some areas the characteristics of benign adenoma and in other areas, chiefly near the surface of the tumor many mitotic figures and the appearance of an adenocarcinoma. It was felt that this was a rapidly growing tumor although there was no evidence of invasion of the submucosa (Figs. 1 and 2).

Third admission, June 27, 1922. Since his operation 5 years before the patient had been practically symptom free until 6 months before this entry when he began to be troubled with gas, epigastric pain relieved by soda, and occasional vomiting. He had been able to work and had lost very little weight or strength. Examination of the stomach by X ray showed an appearance suggestive of multiple polypoid masses. Gastric analysis again showed absence of free hydrochloric acid. No blood was found in the stools. There was a moderate secondary anemia with a red count of 4.1 million and a haemoglobin of 35 per cent. Operation was advised and again performed by Dr C. A. Porter. Numerous polypoid growths were felt through the wall of the stomach, which was incised along the anterior surface. Several growths were clamped and excised down to the submucosa and the bare areas sutured with chromic catgut. Partial gastrectomy was considered at this time, but it was not felt that the patient's condition was good enough to justify it. Two days after operation the patient's temperature rose to 103 degrees with a rise in the pulse rate and respirations, and he died 5 days after



Fig 3 Case B R P 922 Low power showing similar appearance of this tumor to the one removed 5 years previously—some areas of simple adenomatous structure and other areas of malignant change.

operation. Examination of the specimen removed from the stomach showed almost exactly the same type of tumor as had been removed 5 years previously: certain areas of which were adenomatous, other areas showing definite signs of adenocarcinoma (Figs 3 and 4). Necropsy showed essential cause of death to be a general peritonitis.

We feel that this tumor began as an adenomatous polyp and later became definitely adenocarcinomatous. It might be classed as carcinoma *in situ*. The interval of 5 years survival without evidence of metastases would indicate that the growth was actually not as malignant as it appeared histologically and presumably means that local excision was sufficient to prevent recurrence. In all probability the second tumor was a new tumor of the same character although we cannot be certain on this point. Judging from this experience, I believe that it would be wise in such tumors to do a subtotal gastrectomy endeavoring thus to eliminate as much of the stomach as possible from which new tumors might arise.

A. F. B. M. G. H. No. 3785, 3, male, aged 67 years, entered the hospital April 12, 1933, complaining of anorexia, heartburn, and epigastric distress of 6 weeks' duration. There had been no relation to intake of food and no nausea or vomiting. There had been a recent loss of about 5 pounds in weight. Physical examination was negative except for slight tenderness in the epigastrium and small bilateral indirect inguinal hernia. Gastric analysis showed no free hydrochloric acid. Gastro-intestinal X-ray film showed a sharply defined oval filling defect, approximately 1 inch in length lying in the pyloric antrum about 1 inch from the pyloric valve. This was a constant defect and could not be displaced in any direction. It appeared to be

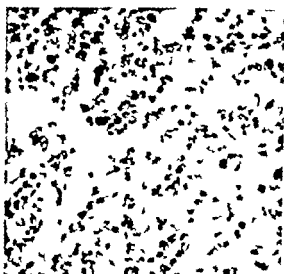


Fig 4 Case B R P 1923 High power showing malignant structure of certain areas shown in Figure 3.

attached to the greater curvature. As peristalsis passed over this area, it was felt the lesion was probably benign, although an early carcinoma could not be excluded. Laparotomy was performed on April 17 by Dr. G. A. Leisner under avertin-ether anesthesia. A lesion was found almost exactly as described by the X-ray department, and a partial gastric resection with Billroth II anastomosis was done. Although the patient appeared at one time to be rallying from the operation, his temperature, pulse, and respirations all rose rapidly and he died the day after operation. Pathological report by Dr. T. B. Mallory showed an oblong polypoid mass, centered over the greater curvature, approximately 3 centimeters from the pylorus, and measuring 5 by 1.5 by 1.5 centimeters. It was attached by a definite pedicle 1 centimeter long and 3 centimeter thick. There was no suggestion of invasive growth at the base of the pedicle either on gross or on microscopic examination. Under the microscope, however, there were found a number of mitotic figures and there were areas of moderate atypical epithelial proliferation, which it was felt warranted a diagnosis of carcinoma *in situ*. A restricted postmortem examination failed to reveal the cause of death.

This tumor in certain areas had all the characteristics of a simple adenomatous polyp, and yet in other areas contained mitotic figures and epithelial cells in atypical proliferation, which makes it probable that it represents an adenomatous polyp undergoing malignant degeneration.

The following case is added to show what we feel the proper management of such cases.

W. J. M., M. G. H. No. 33350, male, aged 58 years, entered the hospital August 15, 1932, with a history of pain and bloating in the epigastrium of 3 months' duration. These symptoms would appear only after meals and would last for about 3 hours. There had been a feeling of weakness for 6 months and a loss of 30 pounds in weight in the past year. X-ray examination showed multiple per-



Fig. 5 Case W. J. M. Typical X-ray appearance of multiple gastric polyps.

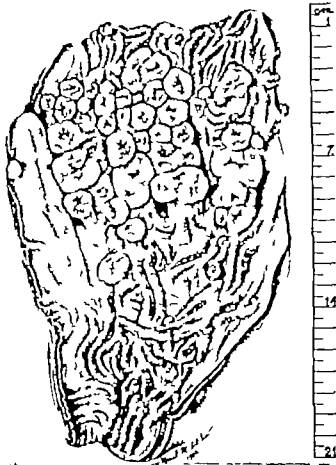


Fig. 6 Case W. J. M. Drawing of specimen removed at operation—multiple gastric polyps.

sized polypoid masses in the greater curvature of the stomach (Fig. 5). Because there was also a 3 year history of sharp intermittent pain in the right flank, pathology in the kidney was suspected, and X-ray film showed a right renal calculus. It was then felt that possibly the stomach symptoms might be due wholly or partially to the kidney stone, and therefore it was considered advisable to operate upon the kidney. Right pyelolithotomy was performed by Dr. Sylvester B. Kelley. The patient's convalescence was uneventful.

Second admission, October 19, 1932. The patient had been completely relieved of genito-urinary symptoms and had regained his former strength. After a full meal he was still troubled with a feeling of distention and some epigastric pain. Re-examination of the stomach by X-ray showed the same multiple, small rounded filling defects previously noted. The appearance was that of multiple polyps, but malignant degeneration could not be positively ruled out. Gastric analysis showed a total acidity equal to 5 cubic centimeters of one tenth normal sodium hydroxide 1 hour after 7 per cent alcohol and 1/4 hour after ergamine. The red count was 4.6 million, hemoglobin 55 per cent, and leucocyte count 13,000, the smear showed marked schromia, some polychromatophilia, moderate anisocytosis, and poikilocytosis. Occult blood was present in the stools on two occasions. After very careful consideration, in view of his symptoms and the possibility of malignant degeneration, it was felt that operation was indicated. Accordingly on November 4 a subtotal gastrectomy was performed by Dr. A. W. Allen. Palpation of the stomach

after the peritoneum was opened revealed multiple polyp throughout the medial four fifths. An incision 3 inches long was made on the anterior wall of the stomach thus exposing an area with numerous polyp, varying from 1 millimeter to 1 centimeter in diameter. The mucosa in this region was literally studded with these polyps (Fig. 6). Three polyps were removed for biopsy and reported by frozen section to be adenomatous. The hand was then inserted into the stomach and it was found that a small area at the cardiac end seemed comparatively free of polyp. The opening in the stomach was closed, the pylorus cut across, and the stomach removed up to within 3 inches of the cardiac orifice. There still remained one polyp on the posterior wall of the unresected portion. This was removed and the stump cauterized. A long loop posterior Polya anastomosis with entero-enterostomy was performed. Pathological report showed over one hundred pedunculated soft, granular polyps from 0.5 to 3 centimeters in diameter. A few isolated polyps were scattered about the central mass. The rugae in the remainder of the stomach seemed larger than normal. None was frankly invading the muscularis or was definitely ulcerated. On microscopic examination the polyps were seen to be made up of a mass of normal glandular tissue in a fibrous tissue framework. There was slight inflammatory reaction about some of the larger polyps, but no evidence of malignancy was seen. The patient's convalescence was uneventful. Seven months after the operation he was seen in the gastro-intestinal clinic, at which time he was free of symptoms, gaining in weight and strength, and back at work.

Although pathologically the polyps in this instance showed no positive evidence of malignancy, they were multiple and adenomatous, gave definite symptoms and might have caused severe bleeding or become definitely malignant.

One further case is also included to indicate an unusual complication viz. severe massive hemorrhage from a small adenomatous polyp.

A. D. M. C. H. N. 35065 male, aged 50 years, entered the hospital February 1, 1933, because of severe hematemesis of 3 days' duration, accompanied by extreme weakness and pallor. For 5 years he had had attacks of upper abdominal pain with occasional vomiting, and at one time 4 years ago he vomited a considerable amount of blood. One year ago he began to complain of tingling and numbness in his hands and feet. Two months ago his epigastric pain became more severe than ever before and was not controlled by diet. Being a Nova Scotian fishing captain, his eating habits had always been very irregular. Physical examination showed a well developed and well nourished man, extremely pale and almost moribund. The tongue was very smooth. The pulse rate was 118 and of poor quality. Blood pressure 125 systolic, 50 diastolic. Laboratory studies showed red count 1,350,000 hemoglobin, 35 per cent, white count, 4,000. Smear showed marked variation in size and shape of the red blood cells, which were well filled with hemoglobin, occasional stippled cells, and polychromatophilia. The platelets were normal. Two normoblasts were seen. In view of the massive hemorrhage, diagnosis of bleeding peptic ulcer seemed most probable, but on account of the blood picture of pernicious anemia, and the known association of gastric polyps with pernicious anemia, Dr. William B. Castle of the Boston City Hospital, who happened to see this patient, suggested bleeding polyps as the diagnosis. Blood transfusion was done on the day of entry and again 3 days later, but, in spite of these, 5 days after entry the blood pressure suddenly dropped to 80, the pulse rose to 150, and the patient died. The day before death his temperature rose to 103.5 degrees and respirations to 35, and some rales were heard at the left base, suggesting an early bronchopneumonia in addition to the hemorrhage. Autopsy confirmed Dr. Castle's diagnosis of hemorrhagic polyp of the stomach and pernicious anemia and showed also a left lower lobar pneumonia. The polyp measured 3 by 1 by 4 centimeter, was pedunculated, and located 4.5 centimeters below the cardia and 4.5 centimeters from the lesser curvature on the anterior wall of the stomach. There was no evidence grossly of invasion of the submucosa or of ulceration of the surface. Microscopically there was well marked gastritis with plasma cell infiltration throughout the entire stomach and the first portion of the duodenum. There was glandular atrophy and no parietal cells were seen. The polyp consisted of a mass of large dilated glands, many of which were filled with polymorphonuclear leucocytes and red cells. At the free margins of the polyp the capillaries were dilated and filled with blood. There was no evidence of malignancy. Pathological diagnosis: bleeding adenomatous polyp.

Although such severe bleeding with haematemesis is rare in polyps of the stomach, moderate

bleeding with gross or occult blood in the stools is by no means rare and should be seriously considered as an indication for surgery.

#### EVALUATION

**Symptomatology.** There is nothing pathognomonic in the history of these patients. Loss of weight and strength, anorexia, epigastric pain, nausea, and vomiting are the most frequent symptoms, but none is invariable. Moderate bleeding by rectum occurs in about 25 per cent of the cases. Fatal bleeding with hematemesis occurred in one case of this group, but is unusual.

**Laboratory findings.** Gastric analysis is likely to show a very low acidity or an achlorhydria. The blood picture frequently is that of a primary anemia. In this series of 17 cases primary anemia was diagnosed five times.

**X-ray examination.** The X-ray study is often the most helpful procedure in establishing the diagnosis, but even the most expert roentgenologist is frequently unable to tell whether a filling defect is due to carcinoma or to a benign tumor.

**Treatment.** Surgery is usually to be advised because of the possibility of hemorrhage or of malignant degeneration. Each case, however, must be decided on its own merits, operative risk, size of lesion, and severity of symptoms should all be carefully considered.

#### CONCLUSIONS

In a series of 17 cases of gastric polyps giving fairly severe symptoms, there was microscopic evidence of potential malignancy in 7 cases, or an incidence of 41.2 per cent.

In view of this high incidence of malignancy and the tendency to moderate or even very severe hemorrhage, radical surgery must be seriously considered in all gastric polyps.

The authors wish to express their thanks to Dr. T. B. Mallory for reviewing the pathology in these cases.

#### BIBLIOGRAPHY

1. BROOKS, A. C. *J. Am. M. Ass.* 1932, xciv, 1670.
2. BROWN, HAROLD and PEARL, FELIX. *Surg. Gynec. & Obst.*, 1936, lxviii, 599.
3. MONTREUX, P. Des polypoides gastriques et leur rapports avec le cancer de l'estomac. *Arch. de physiol. norm. et path.* 4th s. 135, 433, 436.
4. MEYER, K. A. and BRAMS, W. A. *Surg., Gynec. & Obst.* 1932, xlii, 311.
5. MILLER, T. G., ELIZABETH, E. L., and WRIGHT, J. W. *M. Arch. Int. Med.*, 1930, xlii, 841.
6. STEWART, M. J. *Brit. M. J.* 1930, ii, 567.

## EPIPHYSEAL SEPARATION OF THE LONG BONES

E. L. ELIASON M.D., F.A.C.S. AND L. K. FERGUSON M.D. F.A.C.S. PHILADELPHIA

THE frequency of the occurrence of epiphyseal separations makes this subject one of considerable importance to the surgeon dealing with fractures in childhood and adolescence. The accepted teachings lead one to believe that accurate anatomical replacement is desirable to avoid the possibility of deformity caused by cessation of bone growth resulting from premature ossification of the epiphyseal cartilage.

This study of epiphyseal separation of the long bones is based on an analysis of 110 cases from the records of the Surgical Outpatient Department and Surgical Service C of the Hospital of the University of Pennsylvania. The cases are consecutive and have been followed over a period of 1 to 7 years so that the end results can be well determined.

It is our purpose to show the results obtained in this series and to point out (1) that premature ossification of the epiphyseal cartilage occurs comparatively rarely following epiphyseal separations, (2) that the degree of reduction is not a factor in premature ossification of the epiphyseal cartilage (Figs. 1, 2 and 3) and (3) that the extent of the epiphyseal injury cannot always be determined at the time of the original injury.

The functions of the epiphyses are, first, to develop the length of bones; second, to serve in the formation of joints, and third, to serve as attachments for ligaments and tendons. They are intimately attached to the shaft by dense periosteum but have a sort of existence independent of the rest of the bone. Their blood supply is obtained mostly from the periosteal network of arteries which perforate the thin external layer of compact tissue to be distributed throughout the spongy cancellous tissue within. Only one or two small vessels pass from the diaphysis to the epiphysis through the conjugal cartilage. This accounts for the comparatively infrequent occurrence of necrosis of the epiphysis in traumatic separations, even when there is wide displacement (Poland).

Growth of bone takes place from the diaphyseal surface of the epiphyseal cartilage. Ossification is accompanied by a growth of cartilage on the epiphyseal side of the disc until the cartilage finally ossifies. The age at which the epiphyses become ossified and the age at which they join the shaft of the bone varies quite widely in the statements of the numerous authorities on the subject. The

epiphyses ossify first, and bone growth is therefore least at the end of the bone toward which the nutrient artery is directed. Since these arteries run toward the elbows and away from the knees, it would follow that the epiphyses most concerned with bone growth in the upper extremity are the proximal epiphysis of the humerus and the lower epiphyses of the radius and ulna. In the lower extremity however the lower epiphysis of the femur and the upper epiphysis of the tibia are the most active. The fibula, however is an exception to this rule since its lower epiphysis is the last to ossify.

Epiphyseal separations are described as fractures in which the line of fracture lies wholly or in part in the epiphyseal line. They are often associated with a fracture at the end of the diaphysis, and usually the epiphyseal cartilage is carried with the epiphysis in its displacement. When the separation is complete the periosteum is frequently torn from the diaphysis for a considerable distance.

Epiphyseal separations occur with the least trauma in the first decade of life and at this period their reduction is most easily performed. As the child grows older the epiphyseal line becomes more irregular so that greater trauma is necessary to produce separation and more difficulty is experienced in their reduction. The cause of these injuries is, in most cases, trauma producing a strain of the ligaments about a joint. The epiphyseal line, being the weakest point, gives way. Of 293 injuries in the region of joints in patients within the epiphyseal age, separation occurred in 114 cases an incidence of 38.9 per cent. The site of separation was most often at the lower radial and lower humeral epiphyses.

The subjective symptoms are frequently not marked especially in separations of bones of the upper extremities. In many cases the pain is so slight or short lived that the injury is overlooked and regarded as a sprain until after 24 hours or more when sufficient soreness appears as the member is used to recall the injury to the patient's attention. Swelling and ecchymosis may be very slight, especially when the separation is only partial. Many of the objective signs on which the diagnosis of fracture is based may be absent or difficult to elicit. Crepitus when present, is soft or muffled and is frequently described as being like the sensation of wet snow being

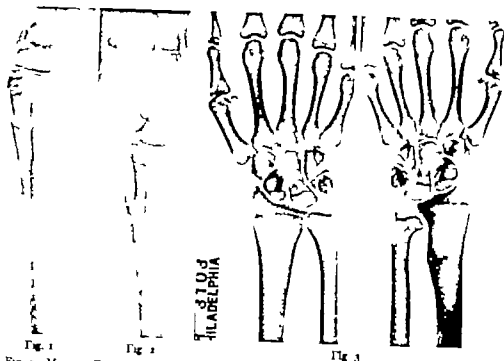


Fig. 1

Fig. 2

Fig. 3

Fig. 1. Minerva F. 13 years. Fell on left forearm April 16, 1923. April 18, 1923, roentgenogram shows adolescent fracture of the radius and epiphyseal separation of the lower ulna with posterior displacement and fracture of the posterior aspect of the ulnar diaphysis.

Fig. 2. Same patient as in Figure 1. May 9, 1923, after reduction showing good reposition of left ulnar epiphysis. Right wrist is shown for comparison.

Fig. 3. Same patient as Figure 1. October 4, 1930. Note complete ossification of the left ulnar epiphysis. Right wrist for comparison.

crunched in the hand. It may easily be mistaken for the soft crepitus sometimes occurring in joints. Prenatural mobility is usually hard to obtain due to the difficulty of grasping the small fragments and to the fact that injury occurs so close to joints where mobility is normally present.

Roentgen-ray diagnosis is also not without difficulty. Injuries which occur before there is an ossified epiphyseal center cannot be demonstrated roentgenologically. Even those which take place after a well formed epiphysis is present are often hard to show unless there is a displacement or an accompanying splitting off of the diaphyseal end of the bone. As a consequence, many roentgenograms of bones in the region of joints of patients in the epiphyseal age are reported as negative, epiphyseal separation not excluded."

The diagnosis of epiphyseal separation then is not difficult when there is displacement of the epiphysis with deformity in the region of the epiphyseal line, or signs demonstrable by roentgenogram. Many injuries in childhood and youth, however, which show none of these signs, are undoubtedly epiphyseal separations of some degree and in these cases the diagnosis must be made

clinically on the basis of the history of an injury, persistent point pressure tenderness at the site of the epiphyseal line, and usually some disability in motion of the adjacent joint. These patients deserve the same treatment as those in whom roentgen diagnosis is made, and in many cases a roentgen-ray diagnosis is possible at a later date when signs of calcifying callus make their appearance (Figs. 4, 5, 6, 7, 8).

Repair takes place following epiphyseal separation in much the same way as it does in the osseous portion of bones. Callus formation is, as a rule, less than that observed in fractures. Union practically always takes place. Accurate anatomical reduction of the fragments is to be desired in these injuries because (1) disabilities may result from deformity of the adjacent joint, especially in epiphyseal injuries about the elbow joint, or (2) there may otherwise be a disturbance in the growth of the bone. Authorities have taught that unless accurate reposition of the epiphysis is accomplished bone growth may be delayed or halted due to premature ossification of the epiphyseal cartilage. This result is infrequent in our experience (Figs. 9, 10, 11, 12).



Fig 4.

Fig 5

Fig 6

Fig 4. Norman G, aged 9 years, fell on left elbow. Roentgen-ray diagnosis: possible epiphyseal separation of the internal epicondyle June 7, 1930.

Fig 5. Same patient. Five weeks later calcification about the detached epiphysis makes diagnosis certain.

Fig 6. John McD, aged 13 years. Fell on right forearm, diagnosis, buckle fracture of radius, supracondylar level, July 27, 1930.

Fig 7. Same patient as Figure 6 August 26, 1930. Four weeks later patient fell from bicycle on right forearm.



Fig 7

Fig 8.

Secondary fracture of the radius. Epiphyseal displacement of the lower ulna now apparent. The callus formation at the epiphyseal line indicates that the ulnar epiphysis was displaced at the time of the first injury.

Fig 8. James D, aged 8 years. Two years before had reduction of posterior dislocation of elbow and separation of the internal epicondyle. He now shows fragmentation of the olecranon with separation of both epicondyles. A normal compound center here must be borne in mind at the olecranon.

A study has been made here of 110 epiphyseal separations, all of which have had positive roentgen diagnoses and are more than one year old. Follow up results were obtained in 60 cases.

These cases were divided as in Table I.

TABLE I—EPIPHYSEAL SEPARATIONS—  
INCIDENCE ACCORDING TO BONES

<b>Radius</b>		
Upper epiphysis		1
Lower epiphysis		48
<b>Humerus</b>		
Head		2
Lower epiphysis		36
External epicondyle	3	
Internal epicondyle	8	
Both epicondyles	24	
	1	
<b>Ulna</b>		
Lower epiphysis		9
Olecranon		1
<b>Femur</b>		
Head		2
Lower epiphysis		3
Lesser trochanter		2
<b>Tibia</b>		
Lower epiphysis		4
<b>Fibula</b>		
Lower epiphysis		2

#### EPIPHYSEAL SEPARATION OF THE LOWER RADIUS

During the growing period epiphyseal separations occur almost as frequently as do fractures in injuries in the region of the wrist. Table II gives the incidence of 141 such injuries occurring in the epiphyseal age taken from the records of our Department of Roentgenology.

The lower radial epiphysis is separated more frequently than any other in the body. In this series are 48 cases nearly as many as all the other types collectively. These separations occur most commonly between the ages of 8 and 18 and are almost always due to indirect trauma—a fall on the hand (38 cases) or cranking a car (7 cases). The symptoms may be very slight when there is little displacement. A localized sharply defined line of tenderness over the epiphyseal line or pain





Fig. 9. Da-kil W., aged 8 years. Fell on outstretched hands. Separation of lower radial epiphysis of both arms, first seen 5 days after the separation had occurred. At attempts at fluoroscopic reduction did not improve the position. Roentgenogram shows position of epiphysis June 9, 1930 right arm.

Fig. 10. Same patient as in Figure 9. Right arm, November 10, 1932. Epiphyseal development apparently normal except for a separation of the ulnar styloid.

Fig. 11. Same patient as in Figure 9. Left arm, June 9, 1930.

Fig. 12. Same arm, November 10, 1932.

on movement of the wrist may be the only signs present in reduced or slightly displaced separations. When displacement does occur it is practically always posteriorly and it produces a deformity which is lower and less marked than is found in the supra-styloid or Colles' fracture in adults. Separations occurring in patients in the teens are frequently associated with a wedge-shaped fracture of the posterior edge of the distal radius, seen most easily in the lateral roentgenogram or a fracture of the ulna, especially of the styloid (Figs. 13, 14, 15, 16).

#### EPIPHYSEAL SEPARATION OF THE LOWER RADIUS AND ASSOCIATED INJURIES

So frequently is a fracture of the ulnar styloid an accompanying injury that any patient in the epiphyseal age showing the injury should be suspected of having an epiphyseal separation of the radius whether or not it is shown in the roentgenogram (Fig. 17). In the diagnosis, tenderness over the ulnar styloid should lead one to think of the

possibility of separation of the lower radial epiphysis in an individual under 20 years of age the approximate time when this epiphysis unites with the shaft.

When displacement is present, early fluoroscopic reduction is the recommended treatment. With the hand in palmar flexion, dorsal pressure over the epiphysis usually will accomplish replacement and once reduced there is little tendency to displacement if the wrist is held in acute palmar flexion. Light plaster splints molded to the part with gauze bandages maintain the reduction. When there is little or slight displacement, a single anterior plaster splint gives sufficient immobilization and permits use of the fingers during the splint wearing period. Early active and passive motion under supervision is encouraged, as in all fractures near joints. Calcification is usually sufficient at the end of 3 weeks to permit removal of the splints with limited function in a sling for another week.

Twenty-eight of the 48 patients have returned for follow-up examination from 2 to 7 years after their injuries. All of those examined have normally functioning arms, without any demonstrable disturbance of growth or any evidence of deformity except a slight thickening of the wrist.

TABLE II—INCIDENCE

	Cases	Per cent
Fracture radius alone	36	
Fracture radius and ulna	33	
Fracture ulnar styloid	7	
	76	54
Epiphyseal separation lower radius plus fracture of epiphysis or ulnar styloid	33	
Epiphyseal separation lower ulna plus fracture radius	1	
Epiphyseal separation lower radius	31	
	65	46

TABLE III—ASSOCIATED INJURIES

	Cases
Epiphyseal separation lower radius alone	16
Epiphyseal separation plus fracture of distal radius	13
Epiphyseal separation plus fracture of distal radius and ulnar styloid	8
Epiphyseal separation plus fracture ulnar styloid	8
Epiphyseal separation both radius and ulna	3

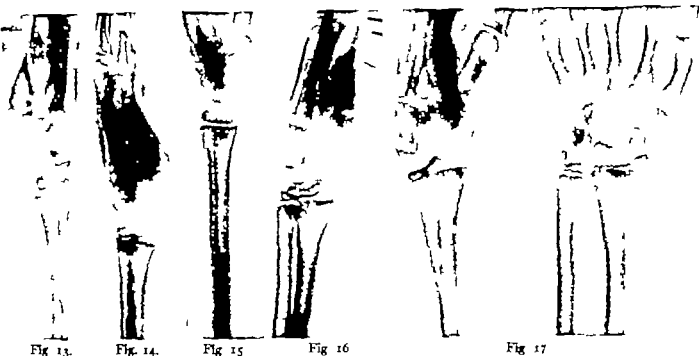


Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

Fig. 17.

Fig. 13 W. K. aged 11 years. Reduced epiphyseal separation lower radius.

Fig. 14 Vince L., aged 11 years. Reduced epiphyseal separation lower radius with slight fracture of the diaphysis.

Fig. 15. Charles B. aged 10 years. Reduced epiphyseal separation lower radius with wedge-shaped fracture of the posterior aspect of the diaphysis.

Fig. 16 Thomas C. aged 11 years. Posterior displacement of the lower radial epiphysis with wedge-shaped fracture of the diaphysis.

Fig. 17 Margaret C., aged 11 years. Marked posterior displacement of the lower radius with fracture of the tip of the ulnar styloid are demonstrated in the roentgenogram.

Six of the patients followed are reported by the roentgenologist to have had incomplete reduction of the epiphysis but the results in these cases were as good as those in which the reduction was perfect (Figs. 18-19 see also Figs. 9-10-11, 12). These patients varied in age from 8 to 14 years and most of them came for treatment some time (3 to 14 days) after their injuries. Unsuccessful attempts at reduction were made in most cases. The results obtained indicate that energetic efforts to reduce the displaced epiphysis in late cases are useless and unnecessary in the younger age groups. Certainly open reduction with replacement of the epiphysis is rarely indicated. The above would seem to indicate that conservatism should be the rule in dealing with displacements of the lower radial epiphysis.

#### SEPARATION OF THE LOWER EPIPHYSIS OF THE ULNA

This epiphysis is formed about the fifth or sixth year and joins the shaft at about the twentieth year. It is firmly united to the radius by the anterior and posterior inferior radio-ulnar ligaments and articulates indirectly with the carpus through the triangular fibrocartilage attached to the base of the styloid. This is the epiphysis which last unites to the shaft and from which

comes most of the longitudinal growth of the ulna.

This separation occurred 9 times in the series. All of the patients but one were between the ages of 13 and 16 years. In each case there was a history of indirect trauma falls on the hand in 5 cases and back fire in cranking automobiles in 4 cases.

Epiphyseal separation of the lower ulna rarely if ever occurs uncomplicated. Because of the indirect relationship which the ulna bears to the hand, the brunt of the force is transmitted to the lower radius and indirectly to the ulnar epiphysis by the strong radio-ulnar ligaments. As a consequence separation of the lower ulnar epiphysis is almost invariably associated with a fracture or epiphyseal separation of the lower radius (Fig. 20 see also Figs. 5 and 6). Posterior displacement of the epiphysis is the rule.

Fluoroscopic reduction of the epiphyseal separation and of the accompanying injury to the radius is the treatment of choice. Usually slight palmar flexion is the position which most easily maintains reduction and light anterior and posterior plaster splints molded to the part gave the most comfortable immobilization. Active and passive motion, with the wrist supported in the grasp of the surgeon's hand, is begun after the

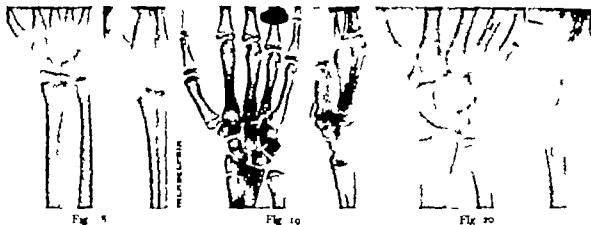


Fig. 18

Fig. 19

Fig. 20

Fig. 18. Eleanor aged 1 year. Came for treatment 5 weeks after fall on the hand. Roentgenogram October 16, 1925, showing marked posterior displacement of the lower radial epiphysis with wedge fracture of the adjacent diaphysis. Attempts at reduction failed to improve the position.

Fig. 19. Same patient as in Figure 18. Roentgenogram

November 2, 1932, 4 years later. Practically normal epiphyseal development. Separation of the ulnar styloid.

Fig. 20. Harry G. aged 16 years. Injured cracking a car. Separation of epiphysis of both radius and ulna at wrist with fracture of the ulnar epiphysis. This patient has a perfect anatomical and functional result 7 years after injury.

first week and the splints are removed in 3 to 4 weeks.

Follow up examinations have been made in 5 cases. All of these have perfect functional results and in 1 case only was there any anatomical deformity. This patient who had also a fracture of the posterior lip of the diaphysis, and a supra-styloid fracture of the radius was reported by the roentgenologist as having had a perfect reduction. She now has a very slight ulnar deviation of the hand which is shown by roentgenogram to be due to premature ossification of the epiphyseal cartilage (Fig. 1). In view of the fact that growth of the ulna takes place mostly from the lower epiphysis, the very slight amount of deformity present is noteworthy. The number of cases of this separation of the epiphysis is not sufficient for us to generalize as to the effect upon subsequent development.

#### SEPARATION OF THE UPPER EPIPHYSIS OF THE RADIUS

The nucleus for the head of the radius usually becomes apparent in the roentgenogram during the fifth year. Ossification occurs from several

centers which join together and unite with the shaft during the seventeenth year. The epiphysis forms only the proximal half of the radial head, and is entirely intra articular. It is surrounded by the firm orbicular ligament. Separation of this epiphysis is rare except in association with posterior dislocation of the elbow.

The single case in this series was sustained by a fall on the outstretched hand. The chief deformity was due to a posterior dislocation of the elbow, the epiphyseal displacement of the radial head was reduced with the reduction of the dislocation (Fig. 21).

The treatment of this injury varies somewhat with the conditions found. If the entire epiphysis is displaced and can be reduced immobilization in the Jones position for 3 to 4 weeks is usually sufficient. If the epiphysis is fractured or so displaced that closed reduction is impossible, operation with removal or replacement of the epiphysis is indicated.

#### SEPARATION OF THE OLECRANON EPIPHYSIS

Separation of the upper epiphysis of the ulna occurs very infrequently. This epiphysis, which appears during the ninth or tenth year, includes the upper part of the olecranon and lies within the insertion of the triceps. Between the ages of 14 and 16 when union with the olecranon occurs, the epiphyseal line is very narrow and may be taken for fracture. Between the fifth and ninth years, two centers of ossification may be seen, but fusion usually takes place during the ninth year.

TABLE IV—INJURIES ASSOCIATED WITH SEPARATION OF LOWER ULNAR EPIPHYSIS

	Cases
Suprastyloid fracture radius	1
Fracture diaphysis ulna and radius fracture above supra-styloid level	2
Radius fracture above supra-styloid level	4
Epiphyseal separation lower radius	2

The single case in our series was a boy of 13 years who fell on his elbow while skating. Separation of the olecranon and fracture of the epiphysis resulted. He made a good recovery after fixation on an internal right angled splint (Fig. 22).

#### EPIPHYSEAL SEPARATIONS AT THE LOWER EXTREMITY OF THE HUMERUS

In order to understand lower humeral epiphyseal separation it is necessary to be familiar with the nature of the epiphyseal development in this region. In one stria of cartilage at the lower humerus ossifying centers are developed for the capitellum, the internal epicondyle, the trochlea, and the external epicondyle, respectively (Fig. 23). During the thirteenth year the three external centers unite to form the lower humeral epiphysis which fuses with the shaft in the sixteenth to seventeenth year. The internal epicondylar epiphysis remains separate and unites with the shaft during the nineteenth year. This means that after the thirteenth year, a separation of the lower humeral epiphysis may leave intact that of the internal epicondyle.

The line of the epiphysis is transverse at birth but in early youth, the age at which most separations occur, it extends obliquely downward and inward from a point just above the external condyle to one below the internal epicondyle. This obliquity of the epiphyseal line may account in part for the frequent lateral displacement of the epiphysis and for the difficulty in maintaining accurate reduction. This difficulty is somewhat compensated for by the fact that the joint capsule is attached above the epiphyseal line, so as to enclose all but the internal epicondyle. Epiphyseal separations therefore enter the elbow joint and consequently cause much intra-articular swelling but no great displacement of the fragments unless accompanied by a severe tear of the capsular ligaments.

Up to the age of 10 about one-fifth of the growth of the humerus is believed to come from the lower epiphysis, but after this time there is little growth from the epiphysis, hence its separation has little effect on the length of the bone, but because of the large part it plays in the formation of the elbow joint accurate reduction is important if normal function is to be preserved (Figs. 24, 25).

Injuries about the elbow in childhood and youth result in epiphyseal separations somewhat less frequently than in fractures. In 93 patients within the epiphyseal age there were 37 (39.8%) in which injuries resulted in epiphyseal separations (Table V).



Fig. 21. Left. H. Y., aged 10 years. Separation of upper epiphysis of radius with fracture of the diaphysis.

Fig. 22. David A., aged 13 years. Separation of the olecranon epiphysis with fracture of the epiphysis resulting from fall on the elbow. Here the existence of multiple ossification centers must be remembered.

TABLE V.—INJURIES ABOUT THE ELBOW JOINT IN EPIPHYSEAL AGE—93 CASES FROM THE DEPARTMENT OF ROENTGENOLOGY

	Cases
Fracture lower humerus	36
Fracture olecranon or coronoid	6
Fracture of head of neck of radius	11
Dislocation of elbow	2
Dislocation and fracture	1
	56
Epiphyseal separation with fracture or dislocation	7
Epiphyseal separation of humerus	
Internal epicondyle	17
External condyle	8
Both condyles	3
Epiphyseal separation of ulna	
Olecranon	2
	37

In this series there were 36 cases of separation of the epiphysis of the lower humerus divided as follows:

TABLE VI.—SEPARATION OF EPIPHYSIS OF LOWER HUMERUS

	Cases
Lower humeral	3
External epicondyle	4
External epicondyle plus fracture of diaphysis	4
Internal epicondyle	24
Both epicondyles	1
	36



Fig. 23. Epiphyseal development of the lower humerus in a child 4 years old. (From Poland's *Traumatic Separation of the Epiphyses*.)

Separations of the lower humeral epiphysis, including the external condyle (Figs. 26-27) may occur at any time from birth to 15 or 16 years of age. The ages in these 11 cases fell between 2 and 13. They may be caused by either direct or indirect trauma and produce much the same symptoms as do supracondylar fractures. There is usually pain and tenderness on use of the elbow and on pressure over the external condyle. Swelling is often considerable, due in part to an effusion into the elbow joint because the joint capsule extends above the epiphyseal line. In about one half of the cases, the patients were not brought for treatment until 2 days or more after the injury. Pain was not a prominent symptom unless joint motion was attempted, and the outstanding symptom was the persisting swelling.

The usual displacement is posterior and/or lateral and in most cases the periosteum is carried back with the epiphyseal fragment. This is probably the cause of the later thickening of the lower end of the bone.

The diagnosis must be made from dislocation of the elbow and supracondylar fracture. The points in this diagnosis may be shown in table form (Table VII).

TABLE VII

Epiphyseal separation	Dislocation	Supracondylar fracture
Motion of forearm	Loss of motion of forearm	Motion of forearm
Malformed crepitus	No crepitus	Crepitus
Olecranon-epicondyle (low normal)	Olecranon-epicondyle (low abnormal)	Olecranon-epicondyle (low normal)
Acromion-epicondyle (low shortened)	Acromion-epicondyle (low normal)	Acromion-epicondyle (low shortened)
Deformity slightly above elbow joint	Deformity at elbow joint	Deformity above elbow joint



Fig. 24



Fig. 25



Fig. 26

Fig. 24. Edith C. aged 11 years. Injured right elbow in sledding accident. Diagnosis, February 4, 1923, epiphyseal separation of the internal condyle with slight displacement of the fragment.

Fig. 25. Same patient as in Figure 24, 3 years, 8 months later. Evidently there was a displacement of the trochlear epiphysis at the original injury. The trochlear and internal condyle have united in medial displacement.

Fig. 26. Raymond L. aged 12 years. Fell striking left elbow. Separation of epiphysis of external epicondyle.

Treatment in cases without displacement consisted in fixation in the Jones position. Where there was displacement fluoroscopic reduction was practiced with the application usually of the Ekstrom plaster dressing, with the arm held in the lateral hyperflexed position for 10 days. Passive motion was given early followed by baking and massage after the third week.

Follow up results were obtained in 9 of the 11 cases. Five of these were without deformity and had perfect function of the elbow. Four showed some limitation of flexion on extension, and in one case there was marked deformity present.

#### SEPARATION OF THE INTERNAL EPICONDYLAR EPIPHYSIS OF THE HUMERUS

The internal epicondylar epiphysis is formed from a separate ossification center which appears at about the fifth year in the cartilaginous plate over the end of the humerus. The development and downward growth of the diaphysis displaces the epiphysis internally so that the internal epicondyle becomes separated from the rest of the lower epiphysis and at the twelfth or thirteenth year is a distinct, detached epiphyseal particle, not communicating with the joint. It unites to the shaft in the twentieth to the twenty-second year. It serves as the origin of many of the flexor muscles of the forearm, viz., the flexor carpi radialis, the flexor carpi ulnaris, the flexor sublimus digitorum, the palmaris longus, and part

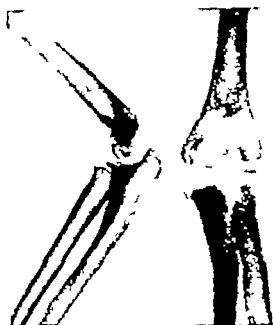


Fig. 27.

Fig. 27. Manuel V. aged 9 years. Fell from tree. Pain and tenderness at epiphyseal line. Reduced epiphyseal separation lower humerus.

Fig. 28. Adele T. aged 8 years. Fell on elbow. Epiphy-

seal separation of the pronator radii teres. This muscular attachment probably accounts for the downward displacement usually found in the separation of this epiphysis (Fig. 28).

One other anatomical point should be emphasized in connection with this separation. The ulnar nerve passes around this epiphysis in a canal the roof of which is formed by a fibrous band passing from the epicondyle to the inner side of the olecranon. This relation of the nerve to the epicondyle accounts for the not uncommon involvement of this nerve in epiphyseal separation.

Separation of the internal epicondyle occurred more frequently than those of the external epicondyle in this series—24 cases. Direct trauma was the cause in 16 of the patients. All but a few patients were boys between the ages of 8 and 12. As in the case with slight separation of the lower humeral epiphysis, the symptoms at the time of injury are often mistaken for those of a sprain but may usually be diagnosed on the basis of pain and sharp tenderness over the condyle swelling on the inner side of the elbow and pain on motion, especially rotation of the arm.

The separation was complicated by a dislocation of the elbow in 2 cases.

The treatment consisted of fixation in the Jones position or on an internal right angle splint for two weeks followed by semi fixation in a sling and physiotherapy.



Fig. 28.

seal separation of internal epicondyle.

Fig. 29. Vincent S., aged 14 years. Fell on arm. Roentgenogram discloses epiphyseal separation of head of humerus.



Fig. 29.

Follow up results were obtained in 15 cases. In 12 cases there was a normal anatomical and functional result. In 3 patients, there was a limitation of motion at the elbow and one case showed some deformity by roentgenogram.

An interesting feature, and one which has not been well emphasized in the literature is that ulnar nerve injury may follow separation of the epiphysis of the internal epicondyle. This complication occurred in 5 cases and was characterized by a numbness or loss of sensation in the ulnar distribution in the hand. The symptoms disappeared under conservative treatment.

#### INJURIES ABOUT THE SHOULDER JOINT

Injuries about the shoulder joint very occasionally produce epiphyseal separations. In this series, there were 2 cases. The upper humeral epiphysis forms during the fifth year from the coalescence of the nuclei of the lesser and greater tuberosities, and that of the head. It unites with the shaft during the nineteenth and twentieth year. The epiphysis is concave and rests on the end of the diaphysis like an inverted cup. It is for this reason difficult to displace, and separations, when they do occur are usually incomplete. Growth of the humerus takes place largely from the upper epiphysis, hence early and accurate reduction is recommended.

The two patients, 11 and 15 years of age, fall within the period when this separation is most

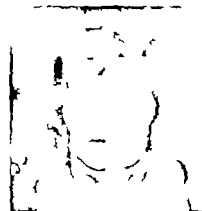


FIG. 30



FIG. 31



FIG. 32

Fig. 30. Margaret F. aged 11 years. Limp without pain in left leg in July, 1930. Limp persisted and on August 26, 1930 this roentgenogram was made and reported negative. Note that the neck of the femur has begun to slip upward and that there is rarefaction at the epiphyseal line.

Fig. 31. Same patient as in Figure 30, December 1930. Two days before patient slipped and fell on an icy slope. Typical appearance of slipping epiphysis of head of femur.

Fig. 32. Same patient as in Figure 30. April, 1932. Appearance of femur 2 years after reduction. Normal line (dual) result.

likely to occur and resulted from accidents in which the arm was forcibly abducted in complete external rotation (Fig. 29).

The symptoms were characteristic of this separation—pain and swelling in the region of the shoulder joint and deformity in which the rotundity of the shoulder is preserved with a depression just below the tip, but not as far down as that noted in fracture of the surgical neck. The patient usually holds the affected extremity in his well hand. The soft crepitus said to be characteristic of epiphyseal separations can be better palpated in this instance than in any other. Roentgen-ray diagnosis is difficult before the fifth year when the three ossifying centers coalesce to form the upper epiphysis proper.

Both cases of this series were easily reduced under fluoroscopic control by traction with abduction and external rotation of the arm and counter pressure over the shoulder. Once reduced there is little tendency to recurrence.

The dressing consisted of a shoulder cap, axillary pad, wrist sling, and body swathe maintained for 3 to 4 weeks. The anatomical and functional results were good in both cases.

TABLE VIII—INJURIES ABOUT THE UPPER HUMERUS IN EPIPHYSEAL AGE 26 CASES FROM THE DEPARTMENT OF ROENTGENOLOGY

	Cases
Fracture surgical neck	18
Fracture below surgical neck	5
Dislocation with fracture of greater tuberosity	3
Epiphyseal separation head of humerus	3
	29

Separation of the epiphyses of the lower extremities occurs much less frequently than in the upper extremity—only 12 cases of the former in our series as compared with 96 of the latter.

#### SEPARATION OF THE CAPITAL EPIPHYSIS OF THE FEMUR

It will be seen that epiphyseal separation occurred more frequently during the epiphyseal age than did fracture in injuries around the hip joint (Table IX). The epiphyseal head of the femur develops from an ossifying center which appears during the latter half of the first year of life. As the shaft grows upward to form the neck of the bone this center becomes separated from that of the greater trochanter. The epiphysis rapidly ossifies, so that at an early age it may be seen in roentgenograms as a bony cap separated from the neck by a thin epiphyseal line. It unites with the shaft at about the twentieth year. The capital epiphysis lies completely within the synovial membrane of the hip joint.

Although the traumatic separation of this epiphysis may occur due to direct violence the

TABLE IX—INJURIES ABOUT THE HIP JOINT IN EPIPHYSEAL AGE

Fracture through base of neck and greater trochanter	1
Fracture upper $\frac{1}{2}$ femur	4
	5
Epiphyseal separation head of femur	6
Epiphyseal separation lesser trochanter	2
	1

incidence of such injuries is slight. In childhood, a fall backward with the leg fixed as when the child is held in arms is said to cause a separation of the epiphysis by extreme extension. This is held by some authors to be the most common injury to the hip in childhood.

The common type of epiphyseal separation of the femoral head is that which occurs in adolescence. It rarely is seen below the age of 10 years. The cause of the separation is not definitely established. Trauma, although apparently an etiological factor does not entirely explain the lesion. Key points out that if the degree of trauma encountered in these cases were sufficient to cause epiphyseal separation in the normal adolescent, then epiphyseal separation would be almost universal because the average adolescent suffers a number of such injuries yearly. Because many of the patients with this lesion are of the fat, overgrown type, Wilson and others believe that an endocrine unbalance probably a hypofunction of the pituitary, plays an etiologic rôle. Balensweig (1) and Buchman (3) look upon the condition as one of a low grade osteochondritis which may be initiated or accentuated by trauma. This theory is supported by the roentgen findings in these cases. Key suggests that during the period of rapid adolescent growth, there may be a stretching, thinning, and consequent weakening of the periosteum spanning the epiphyseal line, thus permitting easy separation of the capital epiphysis on slight trauma.

The names given to this lesion, "slipping epiphysis" epiphyseal coxa vara, femoral osteochondritis of adolescence and so forth are proof of the uncertainty of the etiology (Figs 30, 31, 32).

Separation of the capital epiphysis of the femur occurred twice in this series and both of these were probably cases of so called slipping epiphysis or osteochondritis juvenalis femoris. Both patients were in the usual age period 11 and 13 years, and the history was typical of this disease as it is described. The patients walked with a limp and noted pain in the region of the left hip for a month or more when while walking on level ground they suddenly fell backward. They were unable to walk or to move the affected leg and the foot assumed the everted position with the leg extended so that they were mistaken for fractures of the neck of the femur. The treatment in both of these cases consisted of reduction of the separation under fluoroscopic control. With the limb in extreme abduction a Whitman cast was applied and allowed to remain in place for 8 to 12 weeks. Gradual weight bearing was then en-



Fig. 33 Joseph H. aged 13 years. Fell while running unable to walk. Epiphyseal separation of right lesser trochanter. One year later an identical lesion occurred on left side.

couraged. Both of these patients have good functional results. In one there is a premature ossification of the epiphyseal line with about one inch shortening 6 years after his injury.

#### SEPARATION OF THE LESSER TROCHANTER OF THE FEMUR

The lesser trochanter of the femur appears in the roentgenogram at about the thirteenth year and usually joins the shaft during the eighteenth year. It is rarely separated by direct violence but there are a few cases on record (MacAusland, Sonnenschein) of separation due to muscle pull. The 2 cases in this group occurred in the same patient. The first separation appeared on the right side at 13 years of age and 1 year later separation of the opposite side occurred. In both instances the history of the accident was the same. While running the patient fell, experienced sharp pain in the upper inner thigh and was unable to walk. Examination of the injured part showed no shortening but tenderness and swelling over the upper inner thigh and inability to flex the thigh. This patient made a complete recovery of function after fixation of the legs in spica casts (Fig 33).

#### EPIPHYSEAL SEPARATION OF THE LOWER FEMUR

Injuries about the knee joint in the growing age most often result in sprains or injuries to the cartilages of the joint. Only severe trauma causes fractures or separations of the epiphyses. There were but 10 such injuries in this series divided as in Table V.

The lower femoral epiphysis is believed to be the only epiphysis showing an ossification center at birth. By the fourth year, it has become largely calcified but it does not unite with the shaft





Fig. 34.



Fig. 35.



Fig. 36.

Fig. 34. Thomas W. aged 13 years. Leg was twisted in a football tackle November 15, 1935. Separation of the lower epiphysis of the femur with the typical anterior displacement.

Fig. 35. Roentgenogram of the same patient as in Fig-

ure 34, after reduction. The leg is drawn in the flexed position.

Fig. 36. Same patient as in Figure 34. Roentgenogram 7 years after separation of epiphysis. Firm bony union. One inch shortening, good functional result.

until the twentieth year or even as late as the twenty fifth year in some cases. According to Ollier the growth from the lower epiphysis of the femur is about twice that from the upper. The diaphyseal surface of the epiphysis assumes a shallow cup-shape with a median anteroposterior ridge which fits into a shallow groove between the blunt projections of the condyle portions of the diaphyses. The epiphysis includes the whole of the articular surface of the femur and lies almost entirely within the synovia of the knee, and so it are attached the strong crucial and lateral ligaments of the joint.

Separation of the lower femoral epiphysis is the most common epiphyseal injury in the region of the knee. Indirect violence is the most frequent cause, the tibia acting as a lever to produce hyperextension in the knee joint through its strong ligamentous attachments. In addition, there is often added the factor of torsion. The injury is often spoken of as the "cartwheel fracture" because it was frequently caused by catching the leg in the revolving wheel of a wagon in the days when horse drawn vehicles were more common. In the present day other types of trauma are by far the more common. The separation occurs most frequently between the ages of 8 and 14. The displacement of the epiphysis is usually anterior carrying with it the tibiofemoral articulation, and producing a hemiarthrosis of the knee joint. The sharp posterior edge of the diaphysis projects downward and backward into the popliteal space

(Figs. 34 and 35). This displacement is the cause of the frequent complications of the injuries, viz. injuries to the popliteal vessels and nerves, often necessitating amputation or causing paralysis. Before attempting reduction an examination should be made especially for signs of injury to the popliteal vessels and nerves. MacAnaland and Moorehead emphasize the importance of aspiration of the knee joint in recent injuries. This relaxes the tension in the joint and makes the reduction easier. Reduction is best accomplished by manipulation under general anesthesia with fluoroscopic control. The knee is hyperextended and then by traction upward on the thigh and downward on the leg the epiphysis is replaced in its normal position as the knee is flexed.

According to Patterson, there is little tendency to displacement once reduction has been accomplished. He applies traction with early passive and active motion. A plaster-of-paris cast, holding the leg in acute flexion, is the usual method of treatment, but Cotton and Griswold have discarded this dressing because of the discomfort produced and now maintain the scutech flexed position by simple adhesive. To avoid disability in the knee joint, early motion is advised and Griswold reports an excellent result in a case in which motion in an adhesive dressing was given, beginning on the day after reduction. Although primary operation is advised by some surgeons (Patterson) it seems better to reserve this radical procedure for the late cases or those which cannot be reduced by manipulation under the fluoroscope.

In this series there were 3 cases, all having the typical anterior displacement of the epiphysis. One patient was 12 and the other two 17 years. The youngest patient fell backward with his foot

TABLE V.

	Cases
Fractures of the lower femur	4
Fractures of head of tibia	3
Epiphyseal separation lower femur	3



Fig. 37

Fig. 38



Fig. 39

Fig. 37 Clarence W. aged 10 years. Struck from the side in football. Epiphyseal separation of lower tibia with fracture of the diaphysis and of the lower fourth of the fibula.

Fig. 38 Same patient as in Figure 37 after reduction and the application of lateral molded plaster splints.

Fig. 39 Same patient as in Figure 37 5 years later. No shortening. Normal functional result.

caught in an iron step the 2 other displacements occurred in automobile accidents.

In all 3 cases good reduction was obtained by manipulation under fluoroscopic control. In one patient the dorsalis pedis and posterior tibial gave no pulsation before reduction and in spite of the reduction gangrene of the leg developed necessitating amputation. Perfect anatomical and functional results were obtained in one of the other patients. The third patient had an excellent functional result but about three-quarters of an inch shortening. Roentgenogram shows premature ossification (Fig. 36).

Separation of the upper epiphysis of the tibia occurs very rarely. It is usually the result of direct violence. There are no cases of this injury in this series.

The lower epiphysis of the tibia begins to ossify during the first year of life. By the fourteenth or fifteenth year practically the whole epiphysis is osseous except the thin line of the epiphyseal cartilage. It unites with the shaft during the eighteenth or nineteenth year. The line of the epiphysis is nearly transverse, but its upper surface is traversed by irregular ridges which fit into depressions on the diaphysis to make a rather firm union. The epiphysis forms the entire weight bearing surface of the tibia and the internal malleolus. To its outer edge are attached the strong tibiofibular ligaments.

Most of these injuries are caused by abduction and torsion of the foot or by direct violence (Bishop). The usual displacement is posterior but in the majority of cases the separation is slight in amount. In practically all the cases there is an

#### EPIPHYSEAL SEPARATION ABOUT THE ANKLE JOINT

Separations of the lower epiphyses of the tibia and fibula occur not infrequently in injuries at the ankle during the epiphyseal age. Thirty four injuries in this period taken from the records of the Department of Roentgenology were divided as in Table XI.

Of the 34 injuries of the ankle region in the epiphyseal age, 6 (18 per cent) were epiphyseal separations alone or associated with fractures.

TABLE XI

	Cases
Fractures	
Lower tibia	6
Lower fibula	11
Both bones above ankle	7
Astragalus	4
Epiphyseal separations	
Lower tibia	1
Lower tibia and fracture fibula	2
Lower tibia and fracture fibula and calcaneus	1
Lower fibula	2

TABLE VII.—SUMMARY

Epiphyseal separation	Cases	Cases followed	Good results	Poor results
Lower radius	43	38	35	
Lower ulna	9	6	5	1
Upper radius	1	1	1	
Olecranon		1	1	
Lower humerus	36	24	17	7
Upper humerus	3	2	2	
Head of femur	2	1	1	1
Lower trochanter	2	2	2	
Lower femur	3	3		2†
Lower tibia	4	4	4	
Lower fibula	2	2	2	
	110	75	64	1

† Premature ossification.

† premature ossification, asymptomatic

associated fracture of the diaphysis or of the fibula (Figs. 37 and 38).

In this series there were 4 patients, 10 to 15 years of age. The epiphyseal separation was associated with a fracture in all but 1 case.

The treatment consists of fluoroscopic reduction with the application of lateral molded plaster splints. The splints should be removed at frequent intervals after the first week to give active and passive motion to the ankle joint. After removal of the splints in 4 weeks an elastic bandage or adhesive strapping will prevent excessive swelling during the first few weeks of weight bearing.

The results in the 4 cases were all good. Two patients came for treatment 2 weeks after their injuries. There was fixation of the fragments. In 1 case the epiphysis was considerably displaced posteriorly. Fixation dressings were applied for 2 more weeks. The results in these 2 patients were as good anatomically and functionally as in the cases with good reduction and immediate treatment.

The separation of the lower epiphysis of the fibula is a rare accident. This epiphysis, which begins to ossify during the second year unites with the shaft during the twentieth to the twenty-second year. This epiphysis is the exception to the general rule that epiphyses appear last and unite first when the nutrient artery runs toward them. The nutrient artery of the fibula courses downward but the lower epiphysis appears before the upper and unites with the shaft after it.

The lower fibular epiphysis does not articulate with the tibia, but is joined to it by the strong tibiofibular ligaments. The epiphysis forms the lateral malleolus of the joint and the external malleolus.

There were 2 cases of separation of the lower epiphysis of the fibula in this series. Both patients were boys, 15 and 17 years of age in whom severe direct violence was the etiological factor. There

was only slight displacement of the epiphysis, and the chief symptom was the marked swelling of the outer side of the ankle. Lateral molded plaster splints with a short period of elevation produced perfect results in each case.

#### DEDUCTIONS FROM OUR STUDY

From the results obtained in the treatment of these epiphyseal injuries it is permissible to draw some conclusions which may be useful in the future management of such cases.

1. Perfect reposition of the displaced epiphysis does not necessarily insure subsequent normal growth. (In this series there were only 3 cases of premature ossification of the epiphyseal cartilage. In all 3 instances perfect anatomical reduction was accomplished soon after the injury. The case of premature ossification at the lower ulna has no apparent cause. The second case, one of slipping upper femoral epiphysis, may be explained partially on the basis of an osteochondritis involving the epiphyseal cartilage. The third case at the lower femur was well reduced.)

2. In most instances in our series in which a single epiphysis forms the joint surface partial reposition of the epiphysis was followed by normal subsequent growth (2 to 8 years). This statement is particularly true of the lower radial epiphysis. Especially in the younger age groups nature seems able to compensate for considerable displacement.

3. Perfect reposition is most desirable in those areas where several ossification centers are involved in the formation of the entire epiphysis, e.g. lower humeral epiphysis. Displacement of these epiphyses and subsequent abnormal overgrowth may give marked impairment of motion in such a complicated joint.

4. Injuries in the region of joints during the growing age, even in the absence of roentgen-ray evidence should be considered as possible epiphyseal separations without displacement. Treatment should be carried out with this possibility in mind.

5. The prognosis of epiphyseal injuries should be guarded because of the danger of premature ossification and because the extent of the injury cannot always be determined at the time of injury.

#### SUMMARY

A review of 110 epiphyseal separations is presented and relative comparisons have been made between the incidence of these injuries and fractures in the region of joints in the growing age. The results may be summarized as in Table VII.

Of the cases followed, 85.3% obtained good anatomical and functional results. The results were fair or poor in 13.3% of the followed cases, the majority of these being in epiphyseal injuries of the lower humerus. The three cases with premature ossification have excellent functional results but have been classed with the poor results because of the slight anatomical deformity.

#### BIBLIOGRAPHY

1. BALENWEIG I. Femoral osteochondritis of adolescents and sequelae: epiphyseal separation of hip. *Surg. Gynec. & Obst.*, 1926, xliii, 604-614.
2. BRIDOR PAUL A. Fractures and epiphyseal separation. Fractures of the ankle. *Am. J. Roentgenol.* 1932, xxviii, 49-65.
3. BUCHMAN, JOSEPH. A résumé of the osteochondritides. *Surg. Gynec. & Obst.*, 1929, xlix, 447-453.
4. CORTON F. J. Dislocations and Joint Fractures. 2d ed., p. 367. Philadelphia: W. B. Saunders Co. 1924.
5. GRISWOLD A. S. Early motion in treatment of separation of lower femoral epiphysis: report of case. *J. Bone & Joint Surg.* 1928, x, 75-77.
6. KEY J. A. Epiphyseal coxa vara or displacement of capital epiphysis of femur in adolescence. *J. Bone & Joint Surg.* 1926, viii, 53-117.
7. MACAUSLAND W. R. Separation of the lower femoral epiphysis. *Surg. Gynec. & Obst.* 1916, xxiii, 147-152.
8. METCALF C. R. Separation of the epiphysis of the small trochanter of femur. *J. Am. M. Ass.* 1925, lxiv, 1234-1236.
9. MOOREHEAD J. J. Discussion of paper by Kurlander. *J. Am. M. Ass.*, 1931, xcvi, 516.
10. PATTERSON W. J. Separation of the lower femoral epiphysis. *Canadian M. Ass. J.*, 1929, xxi, 301-303.
11. SONNENSCHEIM H. D. Separation of epiphysis of lesser trochanter of femur: report of case. *Am. J. Surg.* 1926, I, 104-105.
12. WILSON P. D. Displacement of upper epiphysis of femur treated by open reduction. *J. Am. M. Ass.* 1924, lxxviii, 1749-1756.

## PRIMARY OSTEOGENIC SARCOMA OF THE THYROID GLAND

## REPORT OF A CASE

ALBERT C. BRODERS M.D., ROCHESTER, MINNESOTA

Section on Surgical Pathology The Mayo Clinic

AND

JOHN DEJ. PEMBERTON M.D. F.A.C.S., ROCHESTER, MINNESOTA

Division of Surgery The Mayo Clinic

**K**ETTLE in 1919 called attention to the polymorphic capability of malignant epithelial cells, also to the fact that the cells of some carcinomata are polymorphic to the extent that they lose all trace of their epithelial origin and may become indistinguishable from cells of a connective tissue lineage. The tendency of the cells of a number of carcinomata of the thyroid gland to imitate those of malignant connective tissue neoplasms, an activity especially noted by Kettle and Ewing has probably led to reports of an incidence of primary sarcoma of the thyroid gland that is entirely too high. It is our opinion that the more the microscopic features of malignant neoplasms of the thyroid gland are studied in detail the closer is the agreement with Ewing that undoubted primary sarcoma rarely occurs. If sarcoma in general rarely has its inception in the thyroid gland it is reasonable to assume that the occurrence of a primary osteogenic sarcoma that is not a part of a mixed tumor or of a teratoma really borders on the unique. Reports of such cases in the literature are extremely rare.

One of the earliest, if not the earliest report of such a neoplasm was that made by Forster in 1860. He observed a compact nodule of bone imbedded in a spindle cell sarcoma of the thyroid gland of a woman aged 60 years. He was of the opinion that formation of the bone and of the neoplasm were independent processes, but that both originated in the connective tissue of the thyroid gland. It seems safe to assume that the bone in his case was a product of the sarcoma.

Pick, in 1892 reported a case of malignant tumor of the thyroid gland of a woman aged 51 years. The patient had had a tumor of the neck for several years but one of the soft palate had recently developed. Excision of the tumor of the soft palate was soon followed by death and at necropsy the tumor in the neck was found to be composed almost entirely of bony tissue with soft tissue on the periphery. Microscopically the tumor was composed of spindle cells, much fibrous tissue, and bone. Pick observed transitional tissue between bone and sarcoma, as well as the purely sarcomatous and purely bony

tissue. Metastasis was observed in the soft palate, lungs, heart lymph nodes of the neck, liver, stomach, intestine and dura mater. One of the metastatic nodules in the lung contained bony tissue. Pick thought that in this case the bone originated by transformation of the sarcomatous tissue.

Funkenstein, in 1903 described 2 cases of sarcoma of the thyroid gland in which cartilage and bone were produced. He was of the opinion that his cases were similar to the case described by Pick. Metastatic growths were numerous in both of his cases, and some of the metastatic nodules were purely sarcomatous. He considered the lessons in his cases to be osteochondrosarcoma and thought, as did Pick, that the bone originated from the sarcomatous tissue. He was also of the opinion that the absence of bone in some of the metastatic nodules simply meant that these nodules were so recent that the sarcomatous tissue had not had time to form bone.

Chavannaz and Nadal-Pierre, in 1910, reported a case of sarcomatous tumor of the thyroid gland composed of spindle cells, cartilage, and bone similar to the cases reported by the authors named in the foregoing. Solaro, in 1913, reported a case of osteosarcoma of 8 months duration that developed in the left lobe of the thyroid gland of a man aged 46 years. The lesion was excised and was found to be a spindle cell sarcoma containing much bone and cartilage; the bony tissue appeared to be normally formed. The tumor recurred 2 months after operation and, when excised, the recurrent tumor was also found to be a spindle cell sarcoma, but only a few nodules of bone could be seen. Like Pick and Funkenstein Solaro was of the opinion that the bone was formed from the sarcoma. He was furthermore of the opinion that the scarcity of bone in the recurrent tumor could be explained on the hypothesis that the growth was so rapid that there was no time for the production of bone. He considered that the sarcoma might have originated in an osteogenic rest of the thyroid gland derived from the branchial apparatus; however, he was more inclined to the opinion that it

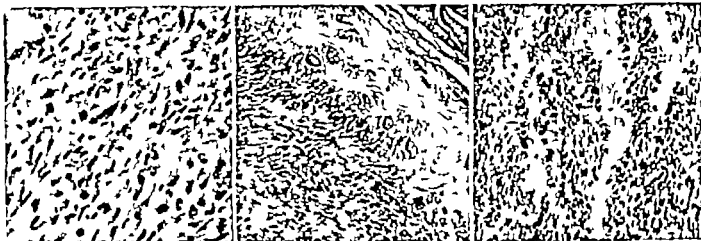


Fig. 1

Fig. 2

Fig. 3.

Fig. 1: Polymorphic sarcoma cells, with scattered mitotic figures.

Fig. 2: Sarcoma cells invasion from within outward of

the adjacent muscle tissue is readily noted

Fig. 3: The development of sarcomatous osteoblasts out of the sarcoma cells and the formation of osteoid tissue.



Fig. 4.

Fig. 5

Fig. 6.

Fig. 4: The development of osteoid tissue into true bone with osteoblasts.

Fig. 5: An area of true bone in which the osteoblasts have for the most part disappeared thereby simulating the

picture of a bony sequestrum, is shown in the photomicrograph.

Fig. 6: An area of thyroid follicles, with true bone lying in close proximity to them.

originated as the result of direct metaplasia of connective tissue.

The case reported by us is the first of its kind that has been observed at The Mayo Clinic in the course of pathological examination of approximately 40,000 thyroid glands.

#### REPORT OF CASE

A man aged 71 years, entered the clinic January 31, 1933, complaining of a growth in the right side of the neck of 4 months duration. His earlier history was not of special significance, except that January 10, 1916 a squamous cell carcinoma graded 1 was excised from his lower lip at the clinic. At that time the submental, right and left submaxillary lymph nodes and the right and left submaxillary salivary glands were removed. Examination of the lymph nodes and salivary glands did not reveal any evidence of metastasis. There was no evidence of recurrence of the carcinoma of the lip. The lesion in his neck

had developed gradually hoarseness and cough had been present for 3 weeks, and the patient had lost 5 pounds in the last 3 months.

In the right side of the neck, between the common carotid artery and the trachea a hard, partially fixed mass, 6 by 6 centimeters in diameter was noted. The growth had displaced these structures respectively to the right and left, and moved with the trachea. The right vocal cord was fixed in the median line, and there was some bulging of the lower part of the right lateral wall of the hypopharynx. A clinical diagnosis of carcinoma of the thyroid gland was made.

An exploratory operation by one of us (Pemberton) revealed a tumor involving the right lobe of the thyroid gland. This tumor was firmly adherent to the side of the trachea and larynx, and was also adherent posteriorly along the line of the blood vessels. A specimen of the tumor was removed for biopsy. Microscopic examination revealed that the lesion was an osteogenic sarcoma. Ten 5 milligram radium needles were inserted into the substance of the tumor 1 to 1.5 centimeters apart, and were left in

place for 24 hours, making a total dose of 1,300 milligram hours. The sarcoma caused death October 1933.

**Microscopic examination.** The neoplasm was varied in structure for in some areas there were only polymorphic sarcoma cells, a few of which were in a state of mitosis (Fig. 1). In other areas sarcoma cells invaded the adjacent musculature from within outward (Fig. 2). In still other areas could be seen sarcomatous osteoblasts which had arisen out of the sarcomatous tissue and which in turn were making osteoid tissue (Fig. 3). Also could be seen the transformation of osteoid tissue into true bone by osteoblasts that were indistinguishable from normal osteoblasts (Fig. 4). Such areas led directly into areas of bony tissue which had no resemblance to sarcoma. This bony tissue with its scanty and atrophic osteoblasts, resembled to some extent a bony sequestrum (Fig. 5). In different parts, islands of thyroid follicles were seen, some of which had bony tissue in close proximity (Fig. 6).

The question arises how can one account for the presence of a primary osteogenic sarcoma in such an unusual situation? The hypothesis that it arose from embryonic rests may explain the presence of this and similar neoplasms in odd situations. We are of the opinion, however, that it is not necessary even to consider such an hypothesis in this case, for the most tenable idea is that the sarcoma arose from the stroma of the thyroid gland by dedifferentiation or anaplasia, of fibroblasts. By taking the latter view we are in practical agreement with the concept of origin held by Foerster and by Solaro. We agree with

Pick, with Funkenstein and with Solaro that the bone is a direct descendant of sarcomatous tissue and in support of this contention Figures 1 to 6 reveal the steps in the process of cellular differentiation by which the sarcoma cells produce sarcomatous osteoblasts, which in turn produce osteoblasts that are indistinguishable from those of benign osteoblasts, followed by the formation of osteoid tissue and true bone. Furthermore, this supports the contention that we are dealing with a true osteogenic sarcoma in contradistinction to a sarcoma enveloping osteoid tissue or bone.

#### BIBLIOGRAPHY

1. CHIVANNAZ AND NADAL PIERRE. Tumeur mixte maligne du corps thyroïde. J. de méd. de Bordeaux, 1910, xl, 8 7-820.
2. FOWDER, JAMES. Neoplastic Diseases. 3d ed. Philadelphia W. B. Saunders Co. 1913.
3. FOERSTER. Ueber die Geschwulste der Schilddrüse. Wiertel. med. Ztschr., 1860, l, 24 36.
4. FUNKENSTEIN, O. Ueber Osteochondrosarkome der Thyroidea. Arch. f. path. Anat. u. Physiol. 1903, cxviii, 34-79.
5. KITTLE, E. H. On polymorphism of the malignant epithelial cell. Proc. Roy. Soc. Med. Sec. Path. pt. 3 1910, xli, 1-12.
6. PICK, F. Zur Kenntnis der malignen Tumoren der Schilddrüse insbesondere des Sarcoma ossificans. Ztschr. f. Heilk., 1892, xlii, 71-86.
7. SOLARO, GIUSEPPE. Osteosarcoma della ghiandola tiroide. Clin. Chir. 1913, xxi, 110 1116.

# OPERATIVE TREATMENT OF BILATERAL NEPHROLITHIASIS

## INDICATIONS AND RESULTS

DOZENT DR. THEODOR HRYNTSCHAK, VIENNA, AUSTRIA

From the Urological Department of the Wilhelminen Hospital, Vienna, Austria

OPINION is more or less uniform regarding the indications for surgical intervention in the presence of unilateral nephrolithiasis, great differences of opinion still exist, however, as to the best means of treating bilateral renal and ureteral calculi. Some recommend surgical intervention only in cases in which anuria, total obstruction associated with high temperatures, and other conditions similarly menacing call for an emergency operation. Another group, to which I belong, consider bilateral lithiasis so harmful to the renal parenchyma, that except in certain special cases they favor early removal of the calculi on both sides. A study of 15 personal cases in which the patients survived operation furnishes further justification for my attitude.

Bilateral renal calculi are found in 8 to 20 per cent of the cases of nephrolithiasis. The percentage has not increased within the last decade, notwithstanding the fact that in most countries the number of cases of renal lithiasis has greatly increased—a fact which may throw some light on the probable causes of stone formation. It is hardly possible that the increase in the number of cases of renal calculi is due only to improved methods of detection and investigation or to other extrinsic factors. It would seem, however, that the stability in the percentage of bilateral cases militates against the assumption that diathesis or constitutional or metabolic processes are solely responsible for the formation of calculi and the increase in their frequency. Fedoroff's belief that the relative low percentage of bilateral lithiasis stresses the influence of local conditions on the formation of stones, seems far more correct.

Of late more has been learned about the causes of the formation of a type of stone commonly called secondary or inflammatory calculus, which develops in bacteria laden urine, while the primary calculus develops in aseptic urine. In a series of excellent clinical studies, Hellström clearly demonstrated the powerful influence of cocci infection in the production of secondary stones. I have verified and confirmed his statements by clinical observation examination of calculi, and by experiments on animals. Of 43 microscopically examined secondary phosphatic stones, 37 (or 86 per cent) contained staphylococci, even when the

urine sediment revealed other bacteria and absence of cocci.

I injected cultures of bacteria from lithiasis cases into the ear vein of rabbits in which I had previously produced a slight stricture of the left ureter. Concrements or sand developed in 9 of the 13 animals infected with staphylococci, whereas in another 6 rabbits infected with other bacteria, such as *Bacillus coli lactis*, *aerogenes*, and *proteus*, sand or concrements could never be found although X ray examinations and necropsy were performed.<sup>1</sup>

I have laid stress upon this bacterial cause of lithiasis because in a great number of cases the presence of bilateral renal calculi is due to infection by staphylococci, as will be seen later on. It is of great importance to be able to recognize this type of stone because of certain indications for the operative and postoperative treatment.

Other well known causes of calculi formation in which staphylococci often play an active part are (a) diseases and fractures of the bone and injuries of the spine, (b) prolonged immobility, the result of illness or injury. The occurrence of bilateral lithiasis is particularly frequent after the injuries mentioned, which agrees with our conception of some of the causes of stone formation. (c) Foreign bodies, like blood clots, etc. may form the nucleus around which a stone may develop, the so called (post) traumatic stones are thus formed.

However though something has been learned about the pathogenesis of secondary stones, we still know but little as to what are the causes of the formation of "primary" stones, especially the urates and oxalates. One is inclined to assume that a congenital abnormality in the urinary system may play an important part in their formation. For example, I once removed a pyonephrotic kidney in a little girl aged 5 months, who had an ectopic ureter leading into the vestibule of the vagina. About the same time I operated on her father to remove a urate stone in the kidney. The family history of patients with stones will often reveal kidney diseases among relatives. However we presume that a change in the normal balance between crystalloids and protective colloids in the

<sup>1</sup> A short summary of these experiments has lately been published (Klin. Wochenschr. 933, N. 2)



urine or changes of their state of dispersion or in their chemical nature are the determining factors in the formation of a stone nucleus. Certain anatomical or physiological changes in the organs must also have taken place in order to favor the formation and retention of stones within the organ. At any rate we may conclude that several concurrent factors are always required in the formation of a kidney calculus.

#### TREATMENT OF BILATERAL NEPHROLITHIASIS

Should bilateral renal or ureteral calculi be treated surgically or conservatively? To our surprise, the literature still reveals a number of surgeons opposed to the operative treatment; others believe that surgical intervention is indicated only in a very few cases (Fedoroff, Kraus, Rosenstein). The majority of surgeons, however, prefer the more radical treatment (Blum, Hinmann, W. Israel, Ravazani, Smith). Before we state our preference we would stress the fact that we apply the term "bilateral nephrolithiasis" only to those cases in which stones are found on both sides *at the same time*.

We believe that removal of stones is contra-indicated when they are aseptic stones—that is (a) the stones are so small that it is more or less likely they will be spontaneously expelled sooner or later; (b) the stones are fixed in a calyx and cause neither colic nor hemorrhage and cause no obstruction to the urinary flow (so called "silent stones"); (c) non-infected large calculi or coral stones; (d) calculi so numerous that the chances of complete removal of all of them are almost nil. All other aseptic stones should be removed by operation, especially if their location and size are likely to damage the renal parenchyma.

As for calculi in infected urine, we must adhere to the general principle that such stones should be removed operatively as soon as possible. This is especially true if the stones are of staphylococcal origin; the progressive destruction of the renal parenchyma is almost a certainty if these stones are left to grow rapidly as they usually do. If we operate too late the danger of recurrence will be very great.

From this general rule we would exclude those very small stones which are apt to be expelled spontaneously without too great risk of completely obstructing the ureter. A ureteral obstruction, if at the same time the urine were infected with staphylococci, might rapidly bring about complete destruction of the renal parenchyma. We believe that it is better to remove a small stone at once than to be compelled later to perform an emergency operation made necessary by high

fever, chills, renal abscesses or pyonephrosis. Under such circumstances, it is often impossible to remove the whole stone, or all of the stones, in which case it would be necessary to perform a second operation later on. For instance, if a ureteral stone completely obstructs a greatly damaged and infected kidney we make it a rule to perform a nephrostomy first; we do not search for the stone unless we can reach it and remove it through the same incision and without difficulty.

It is difficult to establish general rules as to treatment in the presence of infection and branching stones in both kidneys. The course to take may depend upon various factors, such as the age of the patient, his general condition, the virulence of the infection or whether the patient suffers with colic or fever. The social position of the patient must also be considered, as often it may be necessary to establish a kidney fistula which the patient may have to endure for the rest of his life. Often nephrostomy is the only possible operation in the presence of infection and coral stones, when on account of the poor condition of the kidneys nephrectomy of one is definitely contra-indicated. Nephrostomy in such cases puts an end at least to the progressive destruction of the kidney. The removal of the foreign body, the relief of pressure in the renal cavities, and the abatement of the infection often do much toward recovery of the renal functions (see Cases 8, 10, 13). Removal of such stones without the institution of a permanent kidney fistula often results in early recurrence of stone formation and the beneficial effects of the operation are completely lost.

Naturally it is advisable to refrain from operation in cases of large coral stones. That good results have been obtained by operation even in cases with enormous calculi has been clearly demonstrated by numerous cases reported in literature. Though complete recovery of kidney function is not possible in such cases we may be well satisfied if by operation we have at least prolonged the patient's life.

We believe that the radical treatment of cases of bilateral nephrolithiasis is justified when we consider the danger which the presence of every stone imposes upon the renal parenchyma and the function of the kidney pelvis. As every stone is a foreign body it not only disturbs the finely coordinated neuromuscular mechanism of the excretory system on the diseased side but also it damages the renal parenchyma by mere pressure and by the permanent or the intermittent stagnation in the urinary flow in the pelvis or in the calyces. This stagnation favors the growth of the stone. Thus a vicious circle is produced and the

condition becomes even more grave when infection which sooner or later always sets in speeds up the otherwise slow process of destruction to almost calamitous rapidity. We quite agree with J. R. Caulk, who says: "A stone in the kidney is actively or potentially a menace—actively if accompanied with infection—potentially if not."

Our task is far from being finished once we have removed the stone surgically. This is only the first step in the treatment, the aim of which must be the prevention as far as possible of stone recurrence. Prophylactic treatment must be started at once, in fact during the operation itself inasmuch as we must try never to leave behind any fragments of the calculus (X-ray control during operation) and to ensure a free outflow of the urine (either by nephropexy freeing the ureter from adhesions, or by plastic surgery).

Immediately after the operation we must combat the possibility of recurrence by means of an increased intake of fluids, by diet in order to alter the urinary reaction as determined by the chemical nature of the stone and by treating the infection if present, with antiseptic medication.

Once we have decided to operate, our first problem is to decide on which side to operate first—whether there is a possibility of performing the operation in one stage or whether it must be done in two stages.

Literature gives us but few instances in which a one stage operation has been done to remove bilateral calculi. V. Blum in 1923 was the first to recommend this method. In 1930 I reported 8 cases in which a one stage operation had been done by him and added 5 cases of my own all patients surviving. Kuemmel and Judin also believe that in certain selected cases the one stage operation is indicated. Among the numerous interventions for bilateral renal calculi reported in literature the one stage operation is very seldom mentioned. The only ones I could find were 4 cases reported by Leschniew and Levant (2 cases of pyelotomy on both sides, 1 case of pyelotomy and nephrectomy) 1 case by Tenani (bilateral pyelotomy), 1 by Mamikonoff (pyelotomy and nephrectomy) and 1 by Lohmeyer (pyelotomy and ureterotomy). Frangenheim and Dzienkowski have each reported 2 cases of bilateral pyelotomy in one stage. All patients survived operation so that together with my own 7 cases 26 cases have been reported without mortality.

We regard the one stage operation for bilateral nephrolithiasis the ideal method and we resort to other methods only when extremely grave conditions confront us when the patient is very old when the patient is very fat and there is an asso-

ciated severe infection when the patient's condition is extremely precarious and complicated by high fever because of complete blocking by the stone when the general condition of the patient is bad the non-protein nitrogen content of the blood being above 50 milligrams per cent. At times operation on the first side is more difficult and requires more time than anticipated and we are forced to abandon our plan of performing the operation on both sides at the same sitting.

The type of operation is of less importance to us, though we prefer pyelotomy we are not averse to nephrotomy. After the stone has been accurately localized we are able to remove it through a small incision in the parenchyma. It has become more and more recognized that a small circumscript nephrotomy is not a dangerous procedure entailing postoperative complications or serious damage to the parenchyma. We have always adhered to this belief and experience has confirmed our opinion. We have not only performed in one stage pyelotomy on both sides, but we have also done a nephrotomy on one kidney and a pyelotomy on the other side or we have done a nephrotomy together with nephrectomy. In all cases recovery proceeded without complications.

Let us enumerate the advantages of the one stage over the two stage operation at more or less prolonged intervals. I will repeat the advantages which I have already enumerated in a paper published 3 years ago.

1 Both kidneys are at once freed of the foreign bodies, of infection and stagnation, and as far as possible are restored to normal functional conditions.

2 Local postoperative treatment against infection can be started at once on both sides. If the operation is done in two stages, the infection in the kidney not operated upon persists and is a latent danger to the kidney already treated. Then, too every operation forcing the patient to become inactive not only weakens his organism but retards the urinary outflow and this may be particularly detrimental as we have demonstrated in those cases in which stone formation takes place after spinal injury. Finally the local postoperative treatment of the kidney first operated on must be interrupted during convalescence after the second kidney has been operated upon. The whole course of the postoperative treatment is unnecessarily prolonged because of the interval between the two operations. As the local treatment must be continued until the urine is quite free from infection it is apparent that convalescence after a two stage operation is much longer than after the one stage operation.

TABLE L—ONE STAGE OPERATIONS

Number Sex Age	Type of infection	Operation on		Type of stones	Ultimate results
		I side	II side		
F 26	Staphylococci	Pyelotomy	Pyelotomy	Phosphates	Died 3 years later with tuberculosis of the lung Kidney's healthy
M 26	Bacillus coli	Pyelotomy	Nephrectomy	Left calculus right uric	Recovered
M 47	Staphylococci	Pyelotomy	Nephrectomy	Phosphates	Recovered, though small fragment of stone was left behind
M 49	Staphylococci	Nephrectomy	Nephrectomy	Phosphates	Recovered, though small fragment of stone was left behind
M 48	Staphylococci	Pyelonephrectomy	Nephrectomy	Phosphates	Recovered, died 3 months later with pusitis
M 4	Staphylococci	Pyelonephrectomy Heminec	Pyelotomy Hilary	Phosphates	Recovered
M 14	Stridie	Uretrotomy	Uretrotomy	Calcium	Recovered

3. The side not operated upon remains a source of latent danger to the patient, subjecting him to possible complications such as hæmatoma colic, blocking of the kidney fever pyelonephritis or even the formation of renal abscesses, all of which are avoided when the complete operation is done in one stage. The literature contains reports of numerous cases in which complications attributable to conditions on the side not operated upon arose during the first few days after the first operation.

4. Every complication which may arise after the first operation (pneumonia, thrombosis, suppuration, etc.) may prolong the interval between the two stages. According to Rosenstein at least 6 to 8 weeks should elapse between the first and second stages. Such a considerable length of time may cause irreparable damage to the kidney not yet operated upon. Under the circumstances it is easy to understand the reluctance of the doctor as well as of the patient to run the risk of a second operation.

5. The patient himself will always prefer the one stage operation. In fact, several of our patients even refused to have a two stage operation and gladly submitted to the one stage procedure. For the patient the advantages of the one stage operation are obvious. Once the operation is over they can look forward to final recovery and do not have to face the prospects of a second operation as serious as the first one. Convalescence, after the one stage operation is no longer

than after each operation of the two stage procedure. Not only the physical, but also the financial burden is reduced to half what the patient would have had to bear if the operation had been done in two stages. A further advantage is that he may look forward to normal life and normal work in half the time.

6. Many authors fear that after a one stage operation both kidneys may stop functioning for some time and that anuria may result. Truly this never happens. Even after bilateral nephrotomies carried out in the morning the urinary function usually begins again in the afternoon and the urine collected through the nephrostomy drains becomes macroscopically blood free on the second, sometimes on the third day after operation. Naturally the patient must be given a large amount of fluid (either per os or per rectum or hypodermically).

A study of our own cases, in 7 of which operation was done in one stage and in 8 in two stages, all without postoperative deaths, confirms all our views. Because of the great variation in the clinical picture presented in cases of bilateral nephrolithiasis, we cannot establish precise rules as to when a patient should be operated upon in one stage and when in two stages. Probably such rules can never be made. Very careful examination and preliminary treatment are always necessary and will reveal conclusive data which will enable us to select the type of operation which should be used in each case.

TABLE II.—TWO STAGE OPERATIONS

Number Sex Age—years	Type of infection	Operation on		Type of stones	Ultimate results
		I side	II side		
8 M. 50	Bacillus coli, cocci	Nephrotomy (emergency op.)	Nephrectomy 13 months later	Phosphates	Died a few months later with cancer of the stomach
9 F. 33	Bacillus coli	Nephrotomy (emergency op.)	Nephrotomy 7 months later	Phosphates	Recurrence on the left side
1 F. 43	Bacillus coli	Nephrotomy	Nephrotomy 8 months later (emergency op.)	Phosphates	Unknown
11 M. 50	Bacillus coli	Pyelonephrotomy	Nephrectomy 5 months later	Phosphates	Recurrence, permanent kidney fistula, good health
12 M. 50	Staphylococci	Ureterotomy	Nephrotomy 3 months later	Phosphates	Recovered
13 F. 17	Bacillus coli	Nephrotomy (emergency op.)	Nephrotomy 2 months later (emergency op.)	Phosphates	Recovered
14 M. 60	Staphylococci	Ureterotomy	Nephrectomy 1 month later	Phosphates	Unknown
15 M. 47	Staphylococci	Pyelonephrotomy	Nephrectomy 1 month later	Phosphates	Recovered

The indigocarmine test alone is not sufficient in these cases, as it does not give accurate information as to the condition of the renal parenchyma. The plain X ray pictures must be supplemented with pyeloscopic examination of both sides, an indispensable measure as with no other means can we obtain so accurate a picture of the renal cavities and of the location of the stone. Intravenous pyelography may also be helpful as not only the condition of the kidney is revealed but also the function. During the preliminary treatment, it is of great importance to clear up the urinary infection as much as possible and though we cannot overcome it entirely as long as stones are present, local treatment, diet, and medications will do much to improve the condition.

The next question is, once we have decided to operate, which side shall we do first.

A. The one stage operation. If only one side is infected we naturally will operate first on the aseptic side. But if both sides are aseptic, or as happens more frequently, if both sides are infected we will have to operate first upon the kidney which demands the more conservative treatment. That is we will operate first upon the kidney which requires only pyelotomy, and then upon the kidney which requires either nephrotomy or even nephrectomy. We have repeatedly emphasized the necessity of always choosing the most conservative procedure in cases in which both

kidneys are affected. The condition revealed by operation is often of far greater value in our decisions than all the preliminary functional and radiographic tests. The recuperative power of even severely damaged kidneys once they have been freed of stones and are adequately drained is generally marvelous (see Cases 10 and 13). Therefore, conservatism in the treatment of nephrolithiasis should be strongly emphasized. This is a principle which is readily understood by all those who have seen the astonishing results on renal function, which have followed a longstanding course of treatment by means of a kidney fistula and antiseptic medication.

B. The two stage operation. If it is necessary to resort to the two stage operation we will operate first, provided the functions of both kidneys are equal upon the side which seems to be in the most danger as determined by the preliminary examinations for instance if a stone in the ureter or kidney completely blocks or stagnates the flow of urine. If one kidney is infected and the other not the infected side should be taken care of first. On the other hand if one kidney is damaged to such an extent that nephrectomy seems indicated we will of course operate first upon the other kidney and delay the nephrectomy until the function of the first kidney is improved through adequate treatment. General rules like first operate upon the better then the worse

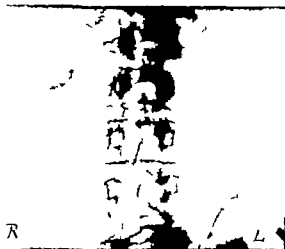


Fig. 1. Case 1. Pyelotomy on both sides in one stage.

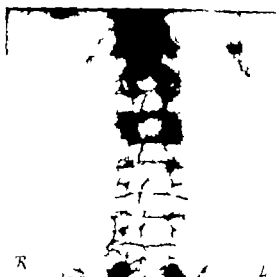


Fig. 2. Case 4. Intravenous pyelography. Left, double kidney, upper pelvis filled out by a stone. Right, bag, infected hydronephrosis. Nephrotomy left and nephrectomy right in one stage.

side are of no value. If satisfactory results are to be obtained, each case must be handled to meet the conditions present in the case at hand.

Sometimes, however, it is difficult to make a definite decision as to which side to treat first. In such cases we must always remember that it is easy to select the time for the first operation but we never know when we will be able to perform the second operation, for all sorts of complications may intervene to delay the second operation indefinitely. In most cases, however, our decision will depend on the history of the case and the condition found in the individual patient.

The following brief histories of 7 of my own cases in which operation was done in one stage and of 8 in which operation was done in two stages confirm my contentions.

#### ONE STAGE OPERATIONS

**CASE 1.** Marie St. female, aged 53 years. Urine from the bladder and both kidneys contained blood, pus, and staphylococci. Indigocarmine given intravenously appeared on both sides after 5 minutes (Fig. 1). Pyelotomy was done on both sides and phosphatic stones were removed. After operation and treatment the urine became clear, pus and bacteria disappeared. X-ray examinations remained negative until patient died 3 years later with tuberculosis of the lungs.

**CASE 2.** Rud. A. male, aged 36 years. In 1914 patient sustained a severe bone fracture (war injury) and suffered prolonged immobility. He was examined in 1926. Severe pyuria with colon bacillus infection was found. He did not know when the pyuria began. On the right side there was an infected hydronephrosis with about 200 small urate stones; a large oxalate stone completely filled the pelvis and reached into one of the calyces on the left side. At operation a left pyelotomy and a right nephrostomy with removal of the stones on the right side were done. After 6 months of postoperative treatment, the left pelvis was free of pus and bacteria. Two years after the first operation nephrectomy of the drained kidney (Blum) was done. Five

and one-half years after the first operation, patient enjoys excellent health.

**CASE 3.** Johann W. male, aged 47 years. Pus and staphylococci were present on both sides; there was complete obstruction by calculus in the left pelvis, and patient had a high fever. After drainage by means of an indwelling ureteral catheter indigocarmine given intravenously appeared in 10 minutes on the right side and in 4 minutes on the left. July 1923, a right pyelotomy was done and a left nephrotomy. A small fragment of a stone, the size of a millet seed, had been left in one of the calyces, as was revealed by X-ray examination before patient's discharge. This patient consequently refused all adequate postoperative treatment. Four and one-half years after operation the urine is slightly cloudy but an X-ray picture shows no increase in the size of the stone fragment.

**CASE 4.** Dem. E. male, aged 40 years. There were two ureteral orifices on the left, one on the right side of the bladder. The urine of all three pelves contained pus and blood. Large infected hydronephrosis was present on the right side, and the left upper pelvis was completely filled with a branching calculus. No dye was excreted from the right side; excretion was poor from the left opening which corresponded to the upper pelvis and normal from the lower pelvis (Fig. 2). In February 1930, nephrotomy was done on the left side, nephrectomy on the right side and phosphatic stones were removed. A small impacted stone fragment had been left in the uppermost calyx, which on the X-ray plate was overshadowed by the large stone. Three years after the operation, the output of this two-bell left openings was absolutely normal, the urine, clear, containing only a few leucocytes and few bacteria. The roentgenogram showed a very slight increase of the stone fragment.

**CASE 5.** Franz Sch., male, aged 45 years. A stone the size of a bean was noted in the lowest calyx of the right kidney. The urine on both sides contained pus and staphylococci. Indigocarmine failed to appear on left, as right it appeared in 4½ minutes (Fig. 3). Pyelonephrectomy was done on the right side, nephrectomy on the left side.



Fig. 3. Case 5. Pyelonephrotomy right and nephrectomy left in one stage.

Notwithstanding constant local treatment the urine could not be cleared of colon bacillus and cocci. Fifteen months later a stone, the size of a bean had developed and become impacted in the pelvic outlet. Patient had a high fever. A ureteral catheter could not be passed up alongside the stone into the pelvis, therefore operative removal of the stone was accomplished through a nephrostomy. The urine, which was heavily infected at the time of the operation, grew quite clear. Five days after the operation, patient developed bilateral parotitis (metastatic?) and died.

CASE 6. Frits B. male, aged 43 years, had a horseshoe kidney. In the urine from the bladder and both pelvis, leucocytes and staphylococci were noted. Indigocarmine given intravenously on the right side was poorly excreted after 6 minutes only. On the left side good excretion after 3 minutes (Fig. 4). January 1931 a small stone impacted in the top of a calyx made pyelonephrotomy necessary on the left side. The big stone on the right side was removed by pyelotomy. Two years after the operation patient is still under observation. The urine after repeated lavage of both pelvis has grown quite clear, no pathological elements. Roentgenograms were negative.

CASE 7. Karl A. male, aged 54 years. The urine was clear but showed traces of albumin. Indigocarmine appeared on the left side after 12 minutes and was faint blue on the right side there was no color at all. The X-ray examination revealed ureteral stones on both sides: on the right side about 20 centimeters, on the left about 5 centimeters above the bladder. The stone on the right side was the size of a hazelnut, on the left of a small bean. Intravenous pyelography revealed highly dilated calyces, pelvis, and ureters. The non-protein nitrogen content of the blood was 32 milligrams per cent. On December 10, 1931 one stage operation was done on both sides: peridural anesthesia with 60 cubic centimeters of ether was used. Irregularly shaped, fringed oxalate stones were removed. Recovery was rapid without complications. Patient was discharged 16 days afterward. Indigocarmine was given at that time and was excreted fully blue after 8 minutes on the left side, faintly colored after 13 minutes on the right side.

#### TWO STAGE OPERATIONS

CASE 8. Karl N., male, aged 50 years, had frequent colics on both sides since 1909, often with expulsion of

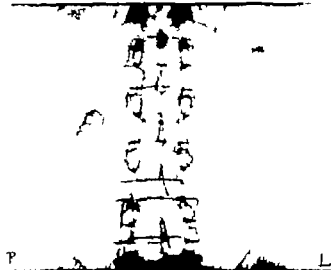


Fig. 4. Case 6. Horseshoe kidney. Pyelonephrotomy left and pyelotomy right in one stage.

stones. In August, 1926 severe pyuria was noted and the colon bacillus and cocci were found. X ray examination revealed stones in both kidneys. On account of the high fever and the swelling of the kidney nephrostomy was done on the right side (Blum, August, 1926). The kidney was filled with stones and purulent urine, and the parenchyma heavily damaged. A phosphatic stone which obstructed the upper part of the ureter could be removed only after a time. During the year after operation stones were frequently expelled and the patient suffered with colic on the left side.

In October 1927 nephrectomy of the completely destroyed pyonephrotic kidney was performed on the left side. Convalescence was rapid. Five months later however the patient died of cancer of the stomach. The post mortem condition of the right kidney could not be obtained.

CASE 9. Marie W. female, aged 33 years, had had coxitis during childhood which had kept her bedridden for 3 years. Fistula had long been present. She had suffered with colic on the right side ever since her childhood illness. In November 1926, Basedow symptoms were noted, the urine contained many leucocytes and colon bacilli. Indigocarmine given intravenously did not appear on the right side after 10 minutes on the left side the dye appeared in 4 minutes and was a pronounced blue. X ray picture revealed stones widely separated on the right side and numerous small and large stones on the left side. Patient refused to undergo operation.

In August, 1927 she had high fever. The right kidney was much enlarged and painful, so nephrostomy had to be performed instantly. The kidney pelvis was found to be greatly dilated and filled with purulent urine. All stones were removed except 4 small ones which had to be left, because the serious condition of the patient did not allow us to prolong the operation. These stones were all expelled spontaneously in the following 5 months. The kidney was drained for 2 months, and the fistula closed a few days after removal of the rubber drain.

In March, 1928 operation was done on the left side. Stones were found in nearly all of the calyces. Two stones could not be found notwithstanding thorough exploration. After operation frequent lavage of the pelvis was carried out. On the right side there was no recurrence of stone. On the left, the stones lying in a calyx slowly became so large that in February 1932 these had to be removed through a



Fig 5 Case 10. Nephrotomy on the right and nephrostomy on the left side in two stages.

nephrotomy. Soon after this the patient left Vienna for 5 months. She came back with hematuria. X-ray examination revealed a recurrence again in the kidney operated upon last. Colon bacilli and cocci were present in the renal urine. We intend to remove the stone soon and to drain the kidney for some months.

CASE 10. Aloisia H. female, aged 43 years, had had pains in both loins for the last 10 years. Of late she had lost considerable weight. There was a tumor on the right side of the abdomen, the urine was strongly purulent and there was scarcely any indigocarmine excretion from either side. A roentgenogram (Fig. 5) was taken. In December, 1920, nephrostomy was done on the right pyonephrotic kidney and the stone removed. Through an accident the kidney drain slipped out 8 days after operation and could not be reintroduced. A small fistula remained and the patient went home. She came back in August, 1927, with anorexia and high fever, non-protein nitrogen 110 milligrams per cent and an emergency operation was done. An enormously dilated left kidney necessitated quick nephrostomy with removal of a very big stone. Other smaller stones lying in the calyces had to be left on account of the extremely bad condition of the patient. During the 4 days after operation 9300 cubic centimeters of urine were collected from the kidney drain, no urine from the bladder. Examination in June, 1928, revealed non protein nitrogen content of the blood 35 milligrams per cent. Indigocarmine appeared on the left side in 10 minutes, on the right side pure pus was excreted when the kidney was squeezed. Dilution and concentration test: specific gravity was 1.009-1.017. After patient's departure from the hospital no more news could be obtained from her. Notwithstanding the uremic condition nephrostomy was effected with astonishingly good results and satisfactory recovery of the kidney function.

CASE 11. Ludwig J. male, aged 50 years, had had purulent pleuritis 6 years before; several ribs had been resected and he had been kept immobile for 7 months. The examination of the urine was found to be purulent and contained colon bacilli. Indigocarmine failed to appear on the left side; on the right side it appeared in 5 1/4 minutes (Fig. 6). A one stage operation was decided on to remove a concreted stone the size of a small cherry in the lower calyx of the right kidney and on the other side the kidney itself as it was completely filled with an enormous coral shaped stone. It was found, however, during operation (October, 1921) that only nephrotomy on the right side could be per-

formed on account of unforeseen difficulties, so nephrectomy had to be postponed until March, 1923. Pelvic lavage presented great difficulties. There was frequent expulsion of soft concretions and finally a ureteral stone the size of a nut formed in the lower part of the widely dilated right ureter. Ureterotomy was done in May 1920. From that date on it was no longer possible to reach the pelvis with the ureteral catheter. More stones formed, and finally the patient suffered with anuria and chills. Twelve hours later through a nephrostomy one stone (June, 1920) was removed. After decapsulation it was found that the kidney surface was covered over with small abscesses. Notwithstanding these abscesses there was no fever after operation and 3000 cubic centimeters of urine was excreted within the first 24 hours. Actually patient enjoys good health, though having to wear a nephrostomy drain.

CASE 12. Siegm. P., male, aged 50 years, had had pain for some time as well as fever and hematuria. The urine was very cloudy and contained leucocytes and cocci. An indigocarmine appeared on the right side after 10 minutes, on the left side it appeared in 5 minutes and was a dense blue. A roentgenogram showed a stone in the right upper ureter (size, 15 by 21 millimeters) on the left side a large stone filled the pelvis and reached into one calyx. As the man was very stout and the heart was not very good, the operation was not performed in one stage. In January 1923, ureterotomy was done on the right side; in March, 1920, nephrotomy on the left side. Phosphatic stones were removed. Intensive postoperative treatment was given. In September of the same year the urine was quite free of pus cells and bacteria.

CASE 13. Isabella P. female, aged 17 years, fell from the fourth floor of a house in July 1921. She suffered fracture of the bony pelvis and calcaneus, injury of the spleen (third and fourth lumbar vertebrae) with complete urinary retention, so that permanent catheter was necessary. In October 1921, for the first time small stones on the right side were expelled during colics. X-ray examination showed a conglomeration of small concretions in the right kidney region. Notwithstanding constant medication with urinary antiseptics, the urine remained very turbid, and stones were frequently expelled. Lavage of the kidney pelvis was done on both sides. In April, 1920, a roentgenogram showed the shadow of a stone the size of a bean on the right side and of another calculus the size of a pea on the left side. Though all fractures were healed, operation on the kidneys had to be postponed as the general condition of patient was so poor that she had to be sent away to convalesce.

In June, 1920, the stone on the right side became impacted in the outlet of the pelvis, and it was impossible to pass a catheter up into the pelvis. Patient had a high fever and it was necessary to do an emergency operation. The kidney presented several small and large abscesses, and during decapsulation because the parenchyma was badly damaged and pulp-soft it was slightly torn so that the stone was extracted through this opening. Nephrectomy which seemed indicated, could not be performed because of the infection and lithiasis on the other side, so a nephrostomy was made. A month later the kidney drain was removed and the fistula closed quickly. At the end of September, 1920, recurrence of almost similar symptoms was noted on the left side. The operation revealed extensive perirenal adhesions, on account of which pyelotomy did not seem advisable. The parenchyma did not appear to be badly damaged. Nephrostomy with removal of the stone was carried out. The drain was taken out a week later. Postoperative lavage was carried out on both sides. In December, examination revealed completely clear urine without pathological elements, normal appearance

time of indigocarmine on both sides and negative roentgenograms.

CASE 14. Mendel T., male, aged 60 years, from 1922 until 1927 had undergone several operations for carcinoma of both mammae and of the lymph glands and had therefore gone through periods of prolonged rest in bed. In May 1930, colics were noted first on the left side. In December 1930, X-ray examination and intravenous urography revealed numerous small and large concretions on the right side, the largest of which was impacted in the upper ureter. The kidney was markedly hydronephrotic. In the left upper ureter was a stone the size of a hazelnut. Intravenous urography revealed after 3 minutes a slight filling of the left pelvis and slightly dilated calyces. Urine analysis revealed *Staphylococcus albus* and aureus. Indigocarmine appeared on the left side in 10 minutes and was faint blue on the right side there was no excretion even after 15 minutes. Non-protein nitrogen content of the blood was 43 milligrams per cent.

In January, 1931 a ureterotomy was done on the left side and a soft phosphatic stone, tightly adherent to the mucosa, was removed. In February, the right kidney was removed. Patient went home (to Poland) in March, 1931 in good health but never answered any of our inquiries about his postoperative health.

CASE 15. Alex. Z., male, aged 47 years. In September 1931 patient had attacks of colics. Roentgenograms showed stones on both sides. As stones were present in both kidneys, patient was dissuaded from operation at that time by his physician. In June, 1932, the indigocarmine excretion on the right side began after 3 minutes, on the left side no blue had appeared after 10 minutes. *Staphylococci* were found in urine from both pelvis. Roentgenogram showed a stone the size of a small cherry in a calyx on the right side; on the left side a calculus blocked the upper ureter and there was present a hydronephrosis (revealed by intravenous urography).

A one stage operation seemed possible. The right side was done first. It was not possible to remove the solidly impacted stone by pyelotomy so a small nephrotomy opening was made just above the stone which then was extracted with difficulty. As patient had suffered considerable loss of blood during nephrotomy and moreover as he suffered with asthma we did not think it advisable to prolong the operation to do a nephrectomy on the other side. That was carried out in July 1932. Actually the urine is clear and contains no bacteria. This case is a good example of the necessity of operating upon patients with bilateral renal lithiasis as soon as possible, in order to stop the process of destruction.

These 15 reports include all personal cases of bilateral nephrolithiasis operated upon on both sides. In 9 of them a one stage operation had been planned (Cases 1 to 7, 11 and 15) and thus decision was carried out in 7 but in 2 cases we met with such difficulties during the operation on the first side, that we did not think it advisable to prolong the operation by attempting to operate upon the other side.

In the 6 other cases the operation in one stage had not been planned, in 4 (Cases 8, 9, 10, 13) an emergency operation had to be performed on account of complete obstruction of one kidney together with high fever and palpable kidney swelling. As in these cases the general condition



Fig. 6. Case 11. Nephrotomy on the right and nephrectomy on the left side in two stages.

of the patients was very bad, we had to work as quickly as possible. We could not even remove all of the stones and were compelled merely to institute a kidney fistula in order to relieve the kidney of the stagnating infection laden urine. In 1 of the 2 remaining cases (Case 12) the condition of the patient, who was very corpulent and much weakened from long lasting fever, did not permit of a one stage operation. In the other (Case 14) as the function of the kidney to be operated upon first could not be depended on at the time and because of the age of the patient, we were reluctant to undertake a one stage operation.

The immediate results in these 15 operations were quite excellent, there were no postoperative deaths and no complications occurred at least within the uropoietic system. As to the more remote results, no recurrence of stones was seen except in Cases 5 and 11. In these cases it had not been possible to obtain complete sterility of the urine by the postoperative treatment. In Case 5 death followed bilateral parotitis after an operation to relieve a recurrence. In Case 11 patient is in excellent health although he has to put up with a permanent kidney fistula. In 6 cases (1, 2, 6, 12, 13, 15) we obtained complete sterility of the urine. Case 14 could not be followed further as patient went abroad and no news could be obtained.

In 3 patients (Cases 3, 4, 9) unfortunately small fragments of stones had been left behind. In 2 of these cases the fragments did not increase in size the patients being still under observation. The kidney function is excellent, the urine is almost





Fig 5 Case 9. Nephrotomy on the right and nephrotomy on the left side in two stages

nephrotomy. Soon after this the patient left Vienna for 5 months. She came back with hematuria. A ray examination revealed a recurrence again in the kidney operated upon last. Colon bacilli and coral were present in the renal urine. We intend to remove the stone soon and to drain the kidney for some months.

CASE 10. Aloisia H. female, aged 42 years, had had pains in both loins for the last 5 years. Of late she had lost considerable weight. There was a tumor on the right side of the abdomen, the urine was strongly purulent and there was scarcely any indigo-carminæ excretion from either side. A roentgenogram (Fig. 5) was taken. In December 1926, nephrotomy was done on the right pyonephrotic kidney and the stone removed. Through an accident the kidney drain slipped out 8 days after operation and could not be reintroduced. A small fistula remained and the patient went home. She came back in August, 1927 with anuria and high fever non-protein nitrogen 119 milligrams per cent and an emergency operation was done. An enormously dilated left kidney necessitated quick nephrotomy with removal of a very big stone. Other smaller stones lying in the calyces had to be left on account of the extremely bad condition of the patient. During the 4 days after operation 9300 cubic centimeters of urine were collected from the kidney drain, no urine from the bladder. Examination in June, 1928, revealed non-protein nitrogen content of the blood 35 milligrams per cent, indigo-carminæ appeared on the left side in 10 minutes on the right side *paræ pus* was excreted when the kidney was squeezed. Dilution and concentration test specific gravity was 1004-1017. After patient's departure from the hospital no more news could be obtained from her. Notwithstanding the uremic condition nephrotomy was effected with astonishing good results and satisfactory recovery of the kidney function.

CASE 11. Ludwig J. male, aged 50 years, had had peritonsillar abscess 6 years before several ribs had been resected and he had been kept immobile for 7 months. The examination of the urine was found to be purulent and contained colon bacilli. Indigo-carminæ failed to appear on the left side on the right side it appeared in 5 1/4 minutes (Fig. 6). A one stage operation was decided on to remove a concretum the size of a small cherry in the lowest calyx of the right kidney and on the other side the kidney itself as it was completely filled with an enormous coral shaped stone. It was found, however, during operation (October 1927) that only nephrotomy on the right side could be per-

formed on account of unforeseen difficulties, so nephrectomy had to be postponed until March, 1928. Pelvic lavage presented great difficulties. There was frequent expulsion of soft concretions and finally a ureteral stone the size of a nut formed in the lower part of the widely dilated right ureter. Ureterotomy was done in May 1929. From that date on it was no longer possible to reach the pelvis with the ureteral catheter. More stones formed, and finally the patient suffered with anuria and chillæ. Twelve hours later through a nephrostomy one stone (June, 1929) was removed. After decapsulation it was found that the kidney surface was covered over with small abscesses. Notwithstanding these abscesses there was no fever after operation and 3000 cubic centimeters of urine was excreted within the first 24 hours. Actually patient enjoys good health, though having to wear a nephrostomy drain.

CASE 12. Siegm. P. male, aged 30 years, had had pains for some time as well as fever and hematuria. The urine was very cloudy and contained leucocytes and cocci. No indigo-carminæ appeared on the right side after 15 minutes, on the left side it appeared in 3 minutes and was a dark blue. A roentgenogram showed a stone in the right upper ureter (size, 12 by 21 millimeters) on the left side a large stone filled the pelvis and reached into one calyx. As the man was very stout and the heart was not very good, the operation was not performed in one stage. In January 1928, ureterotomy was done on the right side. In March 1929, nephrotomy on the left side. Phosphatic stones were removed. Extensive postoperative treatment was given. In September of the same year the urine was quite free of pus cells and bacteria.

CASE 13. Isabella P. female, aged 7 years, fell from the fourth floor of a house in July 1925. She suffered fracture of the bony pelvis and calcaneus, injury of the spine (third and fourth lumbar vertebrae) with complete urinary retention, so that permanent catheter was necessary. In October 1928, for the first time small stones on the right side were expelled during catheter. A ray examination showed a conglomeration of small concretions in the right kidney region. Notwithstanding constant medication with urinary antiseptics, the urine remained very turbid, and stones were frequently expelled. Lavage of the kidney pelvis was done on both sides. In April, 1929, a roentgenogram showed the shadow of a stone the size of a bean on the right side and of another calculus the size of a pea on the left side. Though all fractures were healed, operation on the kidneys had to be postponed as the general condition of patient was so poor that she had to be sent away to convalesce.

In June, 1929, the stone on the right side became impacted in the outlet of the pelvis, and it was impossible to pass a catheter up into the pelvis. Patient had a high fever and it was necessary to do an emergency operation. The kidney presented several small and large abscesses, and during decapsulation because the parenchyma was badly damaged and pulp-salt it was slightly toxic so that the stone was extracted through this opening. Nephrectomy which seemed indicated, could not be performed because of the infection and lithiasis on the other side, so a nephrostomy was made. A month later the kidney drain was removed and the fistula closed quickly. At the end of September 1929, recurrence of almost similar symptoms was noted on the left side. The operation revealed extensive peritoneal adhesions, on account of which pyelotomy did not seem advisable. The parenchyma did not appear to be badly damaged. Nephrostomy with removal of the stone was carried out. The drain was taken out a week later. Postoperative lavage was carried out on both sides. In December, examination revealed completely clear urine without pathological elements, normal appearance

## UTERINE CANCER

A REPORT COVERING THE PERIOD JUNE, 1927 TO JUNE, 1932<sup>1</sup>

C. GORDON JOHNSON M.D., AND CURTIS H. TYRONE, M.D. P.A.C.S., NEW ORLEANS, LOUISIANA

THIS report is purely a statistical one in which certain phases of diagnosis and treatment of uterine cancer are especially emphasized. No attempt has been made to include a follow-up of these cases. There were a total of 959 cases reviewed over this 5 year period. Of these, 926, or 96.6 per cent, were cervical, and 33 or 3.4 per cent, were fundal. These figures coincide closely with those reported from other clinics.

Of the 926 cervical cases, there were 407 or 44 per cent, in white women, and 519 or 56 per cent, in negroes. These figures differ somewhat from those of other clinics, but perhaps this may be explained by the fact that the negro admission at Charity Hospital is practically the same as the white, and also by the fact that the average southern negro woman is more likely to allow cervical lesions to remain untreated, even though they be causing symptoms that the average white woman would not endure. As a result, more prophylactic procedures are carried out on the white woman.

The average age in carcinoma of the cervix was 46, while in that of the fundus was 51 (Table I).

TABLE I.—AGE GROUPING

	CERVICAL		FUNDAL	
	Cases	Per Cent	Cases	Per cent
0-19 years	1	.091	0	
20-29 years	60	6.5	0	
30-39 years	196	21.2	4	12.1
40-49 years	323	35.4	12	36.4
50-59 years	234	25.2	6	18.2
60 over	112	12.0	11	33.4
Total	926		33	

The youngest patient in the cervical group was 15 years old, the oldest patient was 84.

Of the total number of 959 cases, 926, or 96.6 per cent, were multiparae and 33 or 3.4 per cent, nulliparae.

The number of cases in which a microscopic diagnosis of carcinoma was made was 268. This number is perhaps rather small and the importance of a microscopic diagnosis in every case of carcinoma cannot be emphasized too strongly. Of these 268 cases, 93.5 per cent, were epidermoid in type, while 6.5 per cent were of the gland cell type. These figures also compare closely with those given by other clinics (Table II).

TABLE II.—MALIGNANCY CLINICALLY IN CERVICAL CASES

	Cases	Per cent
Early	104	11.5
Late	777	83.0
Untreatable	45	5.5

Clinically the cases were divided into 3 groups early, late and untreatable. By early were meant those cases in which the carcinomatous condition was limited to the cervix alone. There were 104, or 11 per cent, in this group. The late cases were those in which the carcinomatous condition had extended to the vaginal walls or to the parametrial tissue. There were 777, or 83.5 per cent, in this group. The untreatable cases were those in which metastasis throughout the pelvis was so extensive that treatment with radium or deep ray as a palliative procedure was not thought advisable. There was a total of 45 or 5.5 per cent in this group (Table III).

TABLE III.—DURATION OF SYMPTOMS PRIOR TO RECOGNITION OF CARCINOMA

	Cases	Per cent
Under 3 months	260	34
3 to 6 months	220	29
6 months to 1 year	170	22
1 year and over	102	15

One of the main points that has been repeatedly emphasized as to early diagnosis of carcinoma is the duration of symptoms prior to the first visit of the patient to her physician. This is rightfully a most important point, and was carefully determined in our present series. As shown in Table III of the 752 cases in which this point could be determined, the largest number of cases were found in the period under 3 months. There were 260 or 34 per cent, of the total that presented themselves for examination after having symptoms for 3 months or under. This is rather encouraging, as it shows that the laity are gradually learning that the time for examination is at the first suspicious sign of trouble. In the second group, that is from 3 to 6 months there were 220 cases, or 29 per cent. In the third group, that is from 6 months to a year there were 170 cases, or 22 per cent. In the fourth group that is those over a year there were 102, or 15 per cent. Newall in a report from

<sup>1</sup>From Charity Hospital, New Orleans, Louisiana, and Department of Gynecology Tulane University of Louisiana.

Barnes Hospital in 1932, says that of the cases treated there during a 5 year period, the majority had waited for 6 months before applying for treatment (Table IV)

TABLE IV—CASES TREATED BEFORE DEVELOPMENT OF CERVICAL CARCINOMA

Carcinoma following cauterization or some plastic operation on the cervix	10
Carcinoma following abdominal hysterectomies	21

Of equal importance in a statistical report as to the duration of symptoms prior to applying for treatment is the number of cases that have been treated for cervical lesions prior to the development of a cancerous process. The treatment given is usually a cauterization or some type of plastic operation. Hunner subjected 2895 patients with chronic cervicitis to either cauterization or amputation, and after 10 years not one had developed carcinoma. In our series of 926 cases, 10 patients had previously received some type of repair of the cervix, either cauterization or trachelorrhaphy or amputation. Of this group it is possible that a few had a carcinomatous condition present at the time of operation as the interval from time of operation to recognition of the cancer varied from 3 months to 25 years. The majority however developed between 1 and 3 years, there being 4 cases under 1 year. In 21 cases the growths were found in the cervical stump following a supravaginal hysterectomy. The time interval of development of the carcinomatous condition varied from 2 months to 17 years. The majority, however developed within 1 to 3 years. In George Gray Ward's report of 357 cases from the Woman's Hospital of New York City in 1933 there were 19 cases that followed a supravaginal hysterectomy and in Smith's report of 550 cases in the Boston Free Hospital for Women there were 19 cases that followed supravaginal hysterectomy. Both of these reports showed a much higher percentage of patients in whom a cancerous condition developed than in our own series of 926 cases.

We now come to the most important phase of the cancer problem, that is treatment. In our series in 98.5 per cent of the cervical cases, the patients were treated with radium alone or combined with deep ray therapy. In 0.05 per cent patients were treated surgically. In the remaining cases any treatment even as a palliative procedure was impossible. In the fundal cases 70 per cent of the patients were treated surgically and 30 per cent with radium.

As to the amount of radium used in the cervical cases there is a great difference of opinion through-

out the larger clinics and hospitals of the world. The dosages given in our present series vary greatly due to the fact that there has been no standard adopted. On our service, however we have now adopted the following plan. In the early cases the initial dose is a large one namely 3,600 to 4,000 milligram hours, either at one stage or divided into two stages at an interval of 2 to 3 days. No subsequent irradiation is given for a period of at least 3 to 6 months. The amount at that time depends on the course of the disease. In the late cases we usually combine radium in doses of 3,600 to 4,000 milligram hours with the deep ray prior to and following the application of radium.

TABLE V—DOSAGE OF RADIUM USED IN CERVICAL CASES

Cases	Per cent		Mgms. hrs. each
254	31.2	received a total of	2,300
250	31.8	received a total of	2,400
223	24.3	received a total of	2,600
76	9	received a total of	4,800
27	3.7	received a total of	6,000 (or over)

In Table V it is shown that of 839 cases in which the dosage was determined, 254 cases, or 31.2 per cent of the total, received only 2,300 milligram hours each, this amount being quite inadequate. In 250 cases, or 31.8 per cent of the total, only 2,400 milligram hours was given to each. This, in our opinion, is the minimum dose that one could expect results from. Of the remaining cases, 223 or 24.3 per cent, were each given 3,600 milligram hours, 76 or 9 per cent, were each given 4,800 milligram hours, and 27 or 3.7 per cent were each given 6,000 or more milligram hours.

TABLE VI.—NUMBER OF RADIUM APPLICATIONS

Cases	Per cent	Applications
514	62	
11	1	
74	9	2
29	4	4 or more

As to the number of applications of radium used it is shown in Table VI that 514 cases, or 62 per cent of the total, received only 1 application, which in the majority of cases did not exceed 2,400 milligram hours, 11 or 1 per cent, received 2 applications, 74 or 9 per cent, received 3 applications, and 29, or 4 per cent, received 4 or more applications.

TABLE VII.—TREATMENT GIVEN ELSEWHERE

		Initial dose
G. G. Ward	Women's Hospital, New York	1,600-4,800
F. C. Kame	Univ. Pennsylvania, Phila.	2,400
G. U. Newall	Barnes Hospital, St. Louis	2,000-3,000
G. S. Smith	Boston Free Hospital for Women	4,800-5,000
Arthur Curtis	Passavant Hospital, Chicago	2,000-4,000
	Bellevue Hospital, New York	7,500 plus deep ray

In Table VII the treatment with amount of radium used at many of the important cancer centers of this country is given. The standard adopted on our service here compares favorably with the majority of these.

## SUMMARY

- 1 This report covers a review of 959 cases of uterine carcinoma—96.6 per cent cervical, 3.4 per cent fundal.
- 2 The cases were distributed 44 per cent in white women, 56 per cent in colored.
- 3 The average age of the women with cervical carcinoma was 46 fundal, 51.
- 4 In 83 per cent diagnosis was made clinically late on first application for treatment.

5 In the majority of the cases, symptoms had been present for 6 months or under before patients applied for treatment.

6 In 10 cases carcinoma followed either cauterization or some plastic operation on the cervix, in 21 cases the cancer followed supravaginal hysterectomy.

7 The standard treatment used on our service at Charity Hospital is described, and compared to that used elsewhere.

## REFERENCES

- 1 CROSSER, H. S. Modern treatment of cancer of cervix uteri. *J. Missouri Med. Ass.*, 1932, xxix, 1005.
- 2 CURTIS, ARTHUR. Textbook of Gynecology 1905.
- 3 KAME, F. C. End results of radium therapy in carcinoma of the cervix. *Surg., Gynec. & Obst.*, 1933, lvi, 416.
- 4 NEWALL, G. U. Five year end results in treatment of carcinoma of the cervix, Barnes Hospital. *Am. J. Obst. & Gynec.*, 1932, xxiv, 167.
- 5 SMITH, G. VAN S., SMITHWICK, R. H., and ROGERS, HORATIO, JR. Report of cases of carcinoma of the cervix between 1875 and 1927 at Boston Free Hospital for Women. *Am. J. Obst. & Gynec.*, 1928, xv, 637.
- 6 SCHMITZ, H. Correlation between development of growths and symptoms of carcinoma of the cervix. *Am. J. Obst. & Gynec.*, 1932, xxiv, 159.
- 7 WARD, G. G. Carcinoma of the cervix. *Surg., Gynec. & Obst.*, 1933, lvi, 434.

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.

ALLEN B. KARAVEL, M.D.

LOYAL DAVIS, M.D.

Managing Editor

Associate Editor

Associate Editor

DONALD C. BAEFORTH, M.D.

Associate, Editorial Staff

JANUARY 1934

### CONSERVATION OF THE CIRCULATION IN BONE AND JOINT SURGERY

THE circulation undoubtedly should be duly regarded in surgery of all tissues, but the soft tissues are more resourceful in the restoration of blood supply when rendered deficient by operative procedures a pathological process or trauma than is bone and cartilage. Bone is by no means an inert tissue but has an abundant blood supply and one of its chief functions is the storage of calcium with a constant interchange with the blood stream to maintain the proper calcium phosphorus balance for every cell in the body. But the structure of bone is such as to retard revascularization. Hyaline cartilage, which forms the articular surface has practically no blood vessels, consequently has very little restorative power *per se*. When the articular cartilage is injured or the source of nutrition, which is from the blood, is severed there is either degeneration with denudation or repair by invasion of blood vessels and the formation of fibrocartilage or fibrous tissue, thus per-

manently impairing the quality over the area involved.

The physiological repair of bone requires, in the adjacent soft structures from which the circulation is derived an abundant blood supply in consequence the old adage "keep close to the bone" in operative procedure for the purpose of avoiding large nerves and blood vessels, and to secure a better mechanical restoration often defeats the object by destroying the means.

The blood supply to bone is derived from the nutrient artery and from the periosteum through the attachment of soft structures. The vessels from the periosteum are probably of more importance in the process of repair than the nutrient artery. When the blood supply to an area of bone becomes obliterated, either aseptic necrosis or sequestration occurs or there remains sufficient nutrition to keep the part alive but not to instigate the process of repair. In intracapsular fractures of the neck of the femur the main supply is severed at the line of fracture and the only source is derived from the small vessels in the ligamentum teres which may be sufficient to maintain a living head but not to permit callus production or there may not be sufficient supply from this source and the head may become an aseptic sequestrum. Repair then can occur only by invasion of the sequestrum by new bone.

The practical importance of this subject may also be illustrated in all phases of bone and joint surgery in fractures, and whenever the bone is incised for any purpose, there must be an area of stasis between the fragments, surrounded by one of active circulation. If at

the time of trauma there is extensive crushing of the soft structures or if at operation there is extensive stripping of the periosteum and soft parts, healing will be impaired proportionately to the damage. In compound fractures the area of stasis or blood clot is extended and often there is also injury to the surrounding structures and repair is notably materially retarded.

In dislocations, the blood supply may be impaired with subsequent degeneration of the articular cartilage and sequestration of a large portion of the adjacent bone. This has frequently been observed in the hip joint when the roentgenogram shows perfect reduction at the time of dislocation, but after months or years later gross irregularity by sequestration and disintegration. This was first brought to my observation many years ago in a healthy twelve year old boy with perineal dislocation of the hip. In unreduced dislocations of the shoulder and elbow after the elapse of a few weeks the cartilage at open operation shows evidence of fibrillation and degeneration which is often advanced to such a degree that restoration to normal may not occur even after reduction.

In extensive operations upon the knee joint, as in arthroplasty, a much better exposure can be secured by stripping of the periosteum for a considerable distance from the lower extremity of the femur. This undoubtedly facilitates mechanical reconstruction of all parts but later there may be sequestration on the articular surface of the femur and such gross irregularity that even though active motion is secured the purpose of the procedure is defeated. No defect in the articular surface of the tibia is ever noted, for the attachments of the soft structures are not disturbed.

In the hip joint the entire head and neck of the femur may disappear in the same manner when there is too extensive dissection of the

soft structures. The acetabulum is rarely if ever affected as there is sufficient blood supply from the inner surface of the pelvis to maintain contour, therefore extensive denuding of the external surface of the ilium to secure exposure is permitted with impunity.

In osteochondritis dessicans of the knee in which an aseptic sequestrum is formed in the articular surface of the internal condyle of the femur and a loose body is extruded in the joint a small artery, the arteria media in the posterior crucial ligament is probably occluded thus obliterating circulation to this part. If however, as occasionally occurs, this sequestrum through irritation becomes attached to the synovial membrane revascularization occurs and the sequestrum is transformed into active living bone a beautiful natural illustration as to the behavior of free bone grafts. The same manifestations have been observed in the head of the astragalus, after fracture of the neck and after excision and replacement.

In all operative procedures upon bones and joints the incision and approach should be so devised that the circulation is impaired as little as possible. In the knee a sufficient exposure for all purposes may be secured by a linear incision parallel with the quadriceps tendon, patella, and patellar tendon, but, of course, a more tedious procedure is required to reach all recesses. U transverse and other complicated incisions give a better exposure but necessitate severance of important structures. In operations upon fractures of the long bones it is much better to secure only a fifty per cent end to-end engagement than to destroy the most potent means of repair even though a perfect anatomical restoration may be secured.

There are other factors to be considered as, the constitutional status of the patient secretion of certain ductless glands as the para

thyroid and calcium phosphorus balance, vitamins and focal infections. However from a practical point of view the problem has been found a local one in a very large percentage which is chiefly controlled by the local blood supply and if impaired will either result in sequestration or a much retarded process of repair.

WILLIS C. CAMPBELL.

### RELIEF OF ACUTE ADHESIVE INTESTINAL OBSTRUCTION BY SUCTION APPLIED TO IN LYING DUODENAL TUBE

THE borders of medicine and surgery are not fixed but are constantly changing. We are continually striving to find means of treating surgically diseases which are refractory to medical management. At the same time an uninterrupted search is always in progress for conservative agents which may adequately replace satisfactory but more energetic operative intervention. These imaginative pursuits and dreams of medical men are often matters of stern reality to the patient afflicted with an internal disorder for which medicine can do nothing as well as to the patient faced with the prospect of operation for the relief of his complaint. The one asks, May not an operation help me? the other, Can not the same result be accomplished without operation?

Since the advent of the era of surgery of the abdomen operative treatment has had no rival in the management of acute intestinal obstruction, save for early cases of colonic intussusception which may occasionally be reduced by a barium enema. The employment of nasal catheter suction siphonage has demonstrated, however, that a large number of instances of simple acute intestinal obstruction of adhesive origin can be satisfactorily relieved by this means alone without operation. The rationale of its use rests upon

this factor. Intestinal distention engendered by a block in the bowel is due essentially to failure of absorption of swallowed air and the digestive juices (bile, pancreatic juice, and hydrochloric acid) emptied in at the gateway of the intestinal canal. In the same manner that decompression by enterostomy of the gut obstructed by an adhesive band permits intestinal continuity to become automatically re-established so similarly aspiration of the contents of the upper reaches of the distended intestinal tube together with removal of increments of swallowed air and digestive juices as they accumulate often allows spontaneous restoration of the intestinal lumen. Enterostomy presents the following advantage over decompression by the duodenal tube. If following enterostomy, the gut continues obstructed the intestinal tube above the site of drainage can be used as a nutritive tube while one waits to see if automatic release from obstructing mechanism will not occur.

Adhesive occlusions and the distention accompanying inhibitive (paralytic) and spastic types of ileus constitute the chief indications for the employment of suction in the treatment of acute bowel obstruction. In strangulation types of obstruction, whether due to hernia, volvulus, intussusception, or adhesive bands operative interference is urgent. In the enormous distention of the colon not infrequently observed in acute obstructions at the sigmoid flexure, the need for immediate decompression by operation of the ballooned gut is pressing. Correlation of physical findings with the roentgen film of the abdomen permits of surprising accuracy in the identification of the type of obstruction present. When however doubt remains concerning the nature of the obstructing mechanism, especially if uncertainty prevails as to whether a simple or strangulation obstruction be present operation is in order.

In the treatment of mechanical obstructions by suction it is important to follow the decompression by X ray films made at the bedside. Augmentation of the distention, no longer occurring because of the removal of swallowed air and fluid excreted into the stomach and duodenum, the intestinal colic usually stops soon after suction is commenced. The bowel having accommodated itself to a certain grade of distention, no pain will be appreciated if there be no increase in distention. Diminution in caliber of the distended intestinal coils rather than relief of pain herald a successful decompression. The appearance of gas in the colon in complete obstructions of the small intestine indicates that the continuity of the intestinal canal has been restored.

It may readily be shown in the intestine of the intact dog or in the human gut at necropsy that the exertion of suction at the duodenum is appreciated in the same degree at the terminal end of the small intestine in the presence of a pure gaseous or fluid distention of the gut. Such simple gaseous or fluid dis-

tentions may be completely decompressed almost at once. The usual clinical distention unfortunately is constituted by a mixture or alternate segments of gas and fluid in which decompression will be only gradually effected. Many factors affect this issue favorably, such as the elapse of time, with absorption of fluid from the gut resulting in confluence of gaseous increments which may then more readily be aspirated, the churning action of a turbulent gut and posturing of the patient to disarrange the existing collections of gas and fluid facilitating their removal by suction.

During the time when suction is in force para-oral fluids (usually 5 per cent glucose in normal saline) are given in amounts adequate to insure a liberal daily urine output (700 to 1000 cubic centimeters)—a reliable mark of a positive fluid balance.

A large number of instances of acute adhesive obstruction, whether of remote or recent origin, will be spared the necessity of operation for its relief through the use of suction applied to an intubating duodenal tube.

OWEN H. WANGENSTEEN



# EARLY AMERICAN MEDICAL SCHOOLS

## THE MEDICAL DEPARTMENT OF THE UNIVERSITY OF BUFFALO

JOHN L. ECKEL, M.D. BUFFALO, NEW YORK

THE Medical Department of the University of Buffalo was organized by an Act of Incorporation by the New York State Legislature on May 11 1846. This was the culmination of many meetings and much discussion among the leading physicians and prominent citizens of Buffalo which had extended over a period of many years.

During the boom period of the early thirties, a definite move was made to start a university with several departments, but the financial crash of 1836 blasted for a time the laudable plans of its promoters. Buffalo was already a city of some thirty thousand and the need for medical men was felt, hence the final determination of our citizens to compromise on the professional school first with the hope of developing into a full university later. The fact that the Articles of Incorporation called for a university instead of just a medical school, showed the wisdom and breadth of mind of those early pioneers. However while the charter granted was for a university still the medical school was the only department for 40 years, when the pharmacy department came into existence in 1886. The law department followed in 1891 the dental department in 1892 and the analytical chemistry department in 1896, the department of arts and sciences in 1913 the department of education in 1916. Thus from a modest beginning, 86 years ago, when the enrollment was less than 70 students during the first year the total registration in all departments at the present writing is well over 4,200.

Like most institutions of its day the university was first organized as a joint stock corporation and continued so for over 50 years. There is no record of any dividend ever having been declared, but, on the contrary very often there was an assessment to make up deficits that had been made necessary as the result of continued expansion and new equipment, the cost of which exceeded the income from student fees. The loyalty and self-sacrifice of the medical faculty under such conditions has been an enviable tradition,

explaining the continued high standing and success of the medical department. Under such conditions it might be thought that the desire for gain by the stockholders might let down the bars for entrance and scholarship, but on the contrary because of the high type of the faculty such conditions were never permitted to occur.

The original council consisted of 16 members, all stockholders, elected by fellow shareholders, the faculty consisting of 7 physicians, the chancellor and the Mayor of the city *ex officio*. As each department developed, a member from that department was appointed to the council. All appointments to the teaching staff were made by the council upon recommendation of the faculty. Millard Fillmore (Fig. 1) was the first chancellor and continued to act in that capacity for 28 consecutive years, even during his incumbency as president of the United States.

The first faculty consisted of James P. White M.D. professor of obstetrics and diseases of women and children. George Hadley M.D. professor of chemistry and pharmacy. Charles V. Coventry M.D. professor of physiology and medical jurisprudence. Charles A. Lee, M.D. professor of materia medica and pathology. James Webster M.D., professor of general and special anatomy, Frank H. Hamilton, M.D., professor of the principles and practice of surgery and clinical surgery. Austin Flint, M.D., professor of the principles and practice of medicine and clinical medicine. Doctors Coventry Hadley Webster Lee, and Hamilton also held chairs in the Geneva (New York) Medical College, an institution which had an honorable career for a number of years, but on account of its location in a small town, in 1872 it became the medical department of Syracuse University. As these teachers gave the autumn and winter courses at Geneva, the regular lectures at Buffalo did not begin until February. The lectures were preceded by preliminary courses of from 4 to 8 weeks, given by instructors. The enrollment the first year was 66 students. The first commencement exercises were held June 16 1847 at which time 1 degree was con-



Fig. 1 Millard Fillmore

ferred by Chancellor Fillmore. The second session was attended by over 90 students, of which 32 received a medical degree. The department grew in size and importance and soon the necessity for an adequate building was felt. The first three sessions were held in the old First Baptist Church (Fig. 2) at the corner of Washington and Seneca streets. In 1849 at the corner of Main and Virginia streets a fine structure (Fig. 3) of rather unique design was built of brown stone, which was regarded at the time as one of the best adapted buildings of its kind in the country. The cost of this building was contributed largely by the generous citizens of Buffalo. In it provisions were made for a dispensary. In 1849 the Hospital of the Sisters of Charity was organized and its location, adjacent to the college grounds, added greatly to the facilities for medical teaching.

The original faculty all remained during the first 5 years, thus crystallizing the plans and policies, which have been so successful for 86 years. From the original faculty several attained both national and international prominence because of the brilliancy of their work. James P. White, M.D. professor of obstetrics, was the inventor of the White forceps and these are still being used in our day. In 1850 Dr. White introduced clinical midwifery in the college curriculum. While this method of teaching had previously been established in Europe, its introduction into America by Dr. White caused very severe criticism. The newspapers of Buffalo and vicinity attacked Dr. White so bitterly that a suit for libel followed and while the defendant was

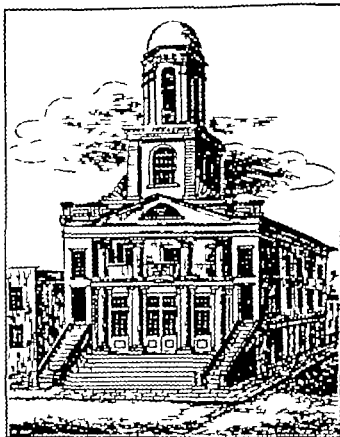


Fig. 2 First home of the medical college, 1840-1848.

acquitted it served to vindicate Dr. White and his method of teaching. It was also Dr. White and his associate, Dr. George S. Burwell, who acting upon the suggestions of Sir James Y. Simpson, of Edinburgh, demonstrated the practical employment of anesthesia in the practice of obstetrics.

Dr. White was a very broad and active man having many interests outside of his specialty in obstetrics. He helped materially in developing the Young Men's Christian Association, the Sisters Hospital, the Providence Retreat, for the care of the insane the Buffalo State Hospital of which he was a member of the board of managers and later president of the board. His services continued with the medical school for 35 consecutive years.

The second internationally known man of that first faculty was Dr. Austin Flint (Fig. 4). In 1842 he was appointed health officer of Buffalo. In 1845 he established the *Buffalo Medical Journal*, and continued as its editor until 1853. In 1846 he was one of the founders of the medical school and continued as professor of medicine until 1859 when he went to New York as professor of medicine at Bellevue Medical College. It was in 1843 that Dr. Flint made his noted observations upon typhoid fever during an epidemic of that disease which occurred in North Boston, New

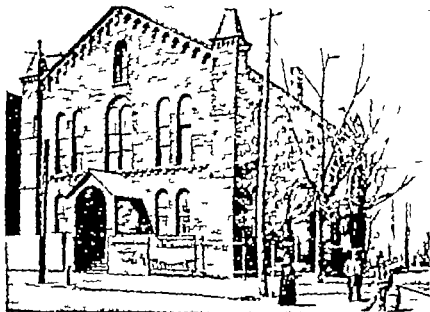


Fig. 3 Second home of the medical college 1849-1893.

York. He contributed greatly toward the recognition, the source, and the means of conveyance of the infection in this dreaded condition. His work on diseases of the chest is a matter of history.

The third famous member of the original faculty was Dr. Frank Hastings Hamilton, who for 15 years was professor of surgery. He was a brilliant teacher and laid the foundation for perfected methods in the management of bone injuries and dislocations. His treatise entitled *Fractures and Dislocations* was translated into several languages. Dr. Hamilton made the first successful skin graft recorded in America, when he took skin from the leg of his patient and covered an ulcer of the opposite leg, 7 by 4 inches. This article was published in the *Buffalo Medical Journal* in December 1854. Dr. Hamilton left Buffalo in 1866 to become professor of surgery in the Long Island Medical College.

Another notable man on the faculty in those early days was Dr. John C. Dalton, Jr. who became professor of physiology in 1851. He was the first in America to employ the method of experimentation on living animals in his teaching.

Dr. Julius M. Minor was another noted surgeon on the faculty in the earlier days, being professor of special surgery. In 1869 he advocated the enucleation of ovarian tumors, a method which has been universally adopted and used to this day.

After the first few sessions of the medical school the length of the course of instruction was

extended to 2 years of 5 months each. After 1870 the course was extended to 3 years of 6 months each. With the birth and development of the science of bacteriology the need was felt for more practical training in pathology and chemistry and a more accurate knowledge of anatomy and histology, all of which demanded increased laboratory facilities and more time. A new building was erected to meet this demand, through the generosity of the citizens of Buffalo, this being built in 1893 (Fig. 5). From 1884 to 1893, in addition to the regular course supplementary and special instruction was given during the spring months. This was followed in 1893 by again lengthening the course to 7 months, and some years thereafter to 9 months for each of the four student years. In 1893 the amalgamation of the medical schools of Buffalo was accomplished, whereby the medical department of Niagara University was merged into that of the University of Buffalo. The former school had been doing excellent work for 15 years, having maintained a high standard throughout. The union was a decided advantage as it served to place at the disposal of one school practically all the available clinical material of the city which at that time numbered well over three hundred thousand people.

Following the Civil War other men on the faculty became renowned. Chief among them was Dr. Roswell Park, who came from Chicago to Buffalo in 1883, as professor of surgery which

chair he held for 31 years. He was a great influence, not only in the school and in the community, but throughout the United States and Europe. His textbook on *The Principles and Practice of Modern Surgery* in two volumes, published in 1907, was one of the best works on surgery ever written. It was he who observed the ever increasing number of cancer cases, and it was he who persuaded the New York State Legislature to found an institution for the study of malignant diseases. This demand was granted and the Institute for the Study of Malignant Diseases was established in Buffalo in 1898, Dr Park being made its first director. During the first 3 years, research work under Dr Park, assisted by Dr Harvey Gaylord, was carried on in the University laboratories. In 1891, through the generosity of Mrs. W. H. Gratwick, of Buffalo the present main building of the Institute was built, which since has grown into several buildings, and thus Buffalo boasts of the first institution in the world devoted entirely to the study of malignant diseases.

Dr Thomas Rochester succeeded Dr Flint as professor of medicine and continued the high standards created by his predecessor until 1887 when after his death he was succeeded, in turn, by Dr Charles G. Stockton, which position Dr Stockton held with honor until 1919. He was one of the outstanding internists of his day and did monumental work in maintaining the high standard of the medical school.

The Medical Department of the University of Buffalo has from the start been co-educational but it was not until 1876 that a woman received a degree. Since then nearly every class has contained several women. The medical school has ever maintained a high standard, ranking favorably with the largest institutions in the country. In the matter of improving medical education it has been in the front rank in enlarging its curriculum and enlarging the corps of its teachers. The school is proud to claim among its teachers, not only the men already mentioned, but such other noted teachers and clinicians as Dr Mathew D. Mann, Dr Charles Cary, Dr Grover W. Wende, Dr James Gibson, and many others.

The building of 1893 with a number of additions, continues to serve the medical department. In 1913 the department of arts and sciences was established. Two years later premedical requirements in the State of New York rose to 2 years' college work. The medical school met this requirement through its department of arts and sciences. In line with the general trend of medical education, the Buffalo school has limited its freshman



Fig. 4. Austin Flint, 1818-1886.

class to 77 members. The average number graduated is approximately 60 in each class.

From the very modest beginning 86 years ago with a faculty of 7 physicians and 66 students there are today in the department approximately 250 students with a faculty consisting of 23 professors and nearly 200 associate professors, assistants, and instructors.

While for many years the school was on a stockholders basis, that condition passed many years ago. The opening of the arts department in 1913 was almost wholly brought about through long planning by the faculty of the medical department, especially Dr H. U. Williams, who foresaw that increased requirements for entrance to the medical department were necessary. The result has been a closer union with the other departments of the university and from this a different method of government and support necessarily followed. In 1915 changes were made transferring the governing power to an administration board of 10 members, nominated by the general faculty and appointed by the council and a board of instruction of 12 members, consisting of the heads of the teaching departments, or those designated by them, and a number of standing committees. Some modification has since been made, and at the present time admin



Fig. 5. Part of present building of the medical department, built in 1893.

istration of the school of medicine is vested in the university council, the Chancellor the Dean, the faculty and two boards—the executive committee and the board of instruction. The executive committee has nominating power of physicians to the faculty while the Chancellor and council must give approval.

The means of support are through fees from students and donations. Since 1921 two huge campaigns appealing to the citizens of Buffalo have been made, each led by the late Walter P. Cooke, each for five million dollars, and each has gone over the top showing the continued interest and generosity of the citizens of Buffalo in this great educational institution. The university has never depended on any one great benefactor

but more on modest donations from a great number of its loyal friends. As a result, Buffalonians look upon the institution as belonging to them. It receives no support whatever from the City of Buffalo. All this demonstrates what unanimity of purpose, effort, and loyalty can do to put forward and perfect an institution.

#### REFERENCES

- PARK, JULIAN. A History of the University of Buffalo, vol. xxii of Publications of the Buffalo Historical Society, 1917.  
 LOOM, E. H. The University of Buffalo: A Brief History 1846-1914.  
 MARTINEAU, SAMUEL A. The medical profession of Erie county New York. Hist. Rev., 1924.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THERE has been no work in English even attempting to cover the subject of the clinical physiology of the eye—a subject in which more advances have been made in recent years than in any other department of ophthalmology. Very little consideration is given to the question in the textbooks, the only exception being the recent large work of Duke-Elder. In the foreign literature the matter is treated in monographs covering particular subjects, or in various parts of large handbooks. Thus the appearance of a single volume covering this subject is a boon to ophthalmologists everywhere and to many physiologists, bio-chemists and psychologists who are interested in the subject.<sup>1</sup>

The author has renounced an attempt to prepare a complete reference book but has chosen what he considers the most important of these works for a discussion simple enough to be read with pleasure by the average clinician who possesses an interest but no technical training, in the more scientific aspects of his subject. The bibliography covering several thousand titles will save much time to workers wishing to go more completely into any special phase.

The author, a clinical ophthalmologist who has done important work in physiology of the eye at the University of Pennsylvania, was well fitted to perform his task. If there is any criticism of his general method, it would be of his reticence in passing personal judgment on many of the subjects discussed in properly emphasizing work of varying importance. Thus Fischer's work on the permeability of the cornea which rests on exceedingly complicated procedures and has never been confirmed might be taken as proved from the author's statements and one wonders just how Tagawa was able to prove the existence of trophic nerve fibers by photographing the cornea. This criticism applies especially to some statements in the first chapter on the Protective Mechanism of the Eye, including the functions of the lids, lacrimal apparatus, cornea, and conjunctiva.

The second chapter deals with the iris and pupil. Again one might gain the impression that the origin of heterochromia iridis from a lesion of the cervical sympathetic was to be definitely accepted, but the discussion of the pupillary pathways and their clinical examination by newer instruments is excellent. It is a subject on which the author has made original contributions. It may be recalled that no satisfactory explanation of the miosis which is associated with the Argyll Robertson pupil has ever been made

The author quotes some evidence that it is due to cord changes which remove the sympathetic inhibitory fibers to the sphincter. These are known to exist as part of the system of reciprocal innervation existing in the iris, as in other muscles. A relative miosis occasionally seen after mastoid operations apparently results from damage to sympathetic fibers which pass through the middle ear.

The mechanism of accommodation which is next considered, is still unsettled. The author summarizes evidence for both the Helmholtz and Tscherning theories. He apparently favors the former as modified by Henderson. The chapter on the lens and vitreous is perhaps necessarily too short to include a great deal of important material, and one misses a discussion of Baermann's work.

Visual acuity is discussed in its physiological aspects and the visual pathways are described, including a discussion of recent work on the projection of retinal elements in the occipital cortex. Of great interest is the discussion of objective changes in the retina during exposure to light. The electrical reactions, too complex for discussion in a review show striking similarity to the phenomena of vision.

In a chapter on the subjective characteristics of vision the phenomena of dark adaptation and other phenomena are well discussed. The discussion of entoptic phenomena will be welcome to the clinician who is often asked their meaning by patients.

A discussion of the ocular movements stresses especially reciprocal innervation which the author has aided in proving for the extra-ocular muscles. The anatomic basis of nystagmus is also presented clearly.

Chapters dealing with the aqueous humor and the intra-ocular pressure take up the vexed question of the genesis and circulation of the aqueous. The author whose work has helped to disprove the secretion theory, believes the aqueous to be a dialysate of the blood, but thinks some circulation out of the eye through the canal of Schlemm must be considered probable.

The typography of the book, except for a number of misprints, is good and the illustrations, chiefly diagrams and records of experiments, are satisfactory.

SANFORD R. GIFFORD

THE Jaschke-Pankow textbook of gynecology has been one of the standard German works for many years. The fourth edition was published eight years ago and the present fifth edition<sup>2</sup> attempts to bring

<sup>1</sup>CLINICAL PHYSIOLOGY OF THE EYE. By Francis Hoad Adler, M.A., M.D. F.A.C.S. New York The Macmillan Company 933

<sup>2</sup>LEHRBUCH DER GYNEKOLOGIE. By Dr. Th. v. Jaschke and Dr. O. Pankow 5th ed., Berlin Julius Springer 951.

the subject matter up to date. This comparatively long gap has necessitated many revisions, some of the chapters being completely rewritten. Many of the illustrations have been replaced by new ones, more have been added, and the large number of drawings in color add to the value of the book as a text.

The section on hormones and on hormone therapy has been completely revised. This subject is admirably handled, and includes all the recent work in this field. The chapter is especially well written in the simple and direct style for which these authors are known.

Pankow is still of the opinion that surgery offers results at least equal to those of radiation in the earlier stages of carcinoma of the cervix. In the section on radiation therapy the author states that 6000 milligram hours is the upper limit of radiation. This is surprising in view of the present day tendency to use larger and ever increasing dosages.

The reader looks in vain for an adequate description of cervical cauterization, for pneumoperitoneum, either transabdominal or transuterine, sedimentation tests, and some of the other newer procedures which are in use at the present time especially in this country.

The sections on the surgery of the various gynecological conditions are also well written. Emphasis is laid on surgical principles rather than on details of surgical technique. For these latter the reader is referred to larger works on surgery. The text has therefore been kept a most readable and useful reference for students and practitioners. It should be read as it is an excellent cross section of present day gynecology as practiced in Germany. Its style and illustrations make it enjoyable as well as profitable. For the *Frauenarzt* it is an excellent companion volume to the *Lehrbuch der Geburtshilfe* by the same authors.

RALPH A. RICH.

KELLOGG has presented us with a most valuable monograph indeed.<sup>1</sup> The duodenum is exhaustively considered from the standpoint of its structure and function, its diseases, and their medical and surgical treatment. As Doctor Stewart aptly says in the foreword "here is gathered all that is definitely known and here is judiciously considered all questions that are still moot. The older surgeons will find it stimulating and practical, the younger will find that, and further that it is time-saving." The subject matter is presented in twenty-six chapters which cover the anatomy physiology of the duodenum and all of its diseases and their treatment. The extensive literature has been thoroughly studied and made readily available. The numerous illustrations which are well selected and instructive include a number of splendid specimens from the museums of the Royal College of Surgeons in Edinburgh and London, Guy's

and Saint Bartholomew's Hospitals which the author personally studied. The reviewer finds no difficulty in according highest praise to Doctor Kellogg for this volume.

FREDERICK CHRISTOWERS.

THE fourth edition of the treatise on the *Science and Practice of Surgery*<sup>2</sup> is dedicated by the authors to their friend and teacher Sir George Makin.

The first volume is devoted to general surgery and covers in a brief way the usual elementary subjects: Antiseptics sterilization pre and postoperative care of patients inflammation infections hemorrhage and anesthesia. The chapters on surgery of blood vessels and nerves are concisely written and there are occasional references to historical operations which have served as the ground work for our present day methods. Chapters 14 to 17 inclusive were written in collaboration with R. H. O. B. Robinson and are devoted to fractures and dislocations. These chapters have been thoughtfully written and display a nice choice of detail in the treatment of the most common fractures and their complications.

Volume II is devoted to regional surgery and the authors have prefaced many chapters with short accounts of applied surgical anatomy and physiology of the region or organ discussed. This feature, the reviewer feels, is an excellent one and will probably find its way into many future publications.

In the preface to the first volume, the authors have stated that they had two main objects in view in presenting this two volume work: the first being to place before the student a book which is sufficiently comprehensive to provide him with all that he will require in passing both his ordinary surgical examinations and any higher examinations to which he may aspire and the second, to present a book which may be of value as a work of reference to the medical practitioner. One is inclined to agree readily that they have attained their goal. The work shows the result of adequate condensation, while its comprehensiveness is quite astonishing.

The illustrations are liberal in number and well chosen. The reviewer however feels that the value of the volume might be enhanced somewhat by a more liberal interpersing of the illustrations with diagrammatic line drawings, which, in some of the recent monographs on surgery have been so instructive.

The reviewer was probably unduly disappointed over the misspelling of the names of his urban colleagues, Frederic Bealey and E. Wyllie Andrews. The incorrect description of the gastrostomy operation devised by Emanuel Senn of Chicago stuck out like a sore thumb.

The reviewer feels that this two-volume edition should be a valuable addition to anyone's library. It, however, will be especially useful to medical students and general practitioners. R. W. McKEAY.

<sup>1</sup>ROBERT'S SURGICAL MONOGRAPHS. THE DUODENUM, ITS STRUCTURE AND FUNCTION, ITS DISEASES AND THEIR MEDICAL AND SURGICAL TREATMENT. By EDWARD L. KELLOGG, M.D., F.A.C.S. With Foreword by George David Stewart, M.D., F.A.C.S. New York Paul B. Hoeber 1934, 7933.

<sup>2</sup>THE SCIENCE AND PRACTICE OF SURGERY. By W. R. G. KESSLER, M.A., M.B., F.R.C.S. (General), F.R.C.S. (Ed.), F.R.C.S. (Surg.), and Philip H. Macdonald, M.D., M.S. (London), F.R.C.S. (Ed.), F.R.C.S. (Surg.), Vol. I. GENERAL SURGERY; Vol. II. REGIONAL SURGERY. Philadelphia: Lea & Febiger 1935.

THE contributors to the first edition of Morris' *Human Anatomy*<sup>1</sup> were ten Englishmen, all of whom were associated with hospitals in or near London, the work itself was designed for the use of students "preparing for the Conjoint Board of the Royal Colleges of Physicians and Surgeons, for the Fellowship of the Royal College of Surgeons" etc. The contributors to the current ninth edition are twelve Americans, who hold or have held, the appointment of professor of anatomy in medical schools in the United States: no one of the original writers of the work, first published forty years ago is on the present list. This change from British to American authorship was well under way with the appearance of the fifth edition—the first under Dr C. M. Jackson's editorship—when eight of the twelve were Americans.

For this thoroughly revised edition, Some parts have been almost entirely rewritten, this applying to the following sections: Special Sense Organs, Urogenital System, Glands of Internal Secretion, Osteology and Articulations, furthermore the "Illustrations have received special attention—a considerable number of those used in the previous edition have been improved and 253 new pictures, of which 92 are in color have been included to take the place of those deleted: this now brings the total to eleven hundred sixty six, an increase by one half again the initial number.

The new edition of the textbook possesses certain general and very valuable features some of which are recent improvements: it contains an entire chapter devoted to the skin as an organ: the material upon clinical and topographical anatomy is now logically distributed among the several chapters, according to the particular organ system affected, the new knowledge of the growth of human body and its parts is made available to the student: serviceable tabulations of muscles by functional groups and by segmental nerve supply are added. Typographically the discriminative plan is retained whereby the student is led first to seek the fundamental facts printed in large type, and later for careful reference, the details printed in small type.

The superb text descriptions which characterize the volume are frequently handicapped by unfortunately inadequate illustrations, many of which have remained unimproved through four decades. This is a curious shortcoming in a text which represents a mature science long since replete with surpassingly excellent pictures, and in an age when fine engraving and color reproduction are commonplace in non-scientific books. The old retained figures seem especially inadequate in the section on musculature, wherein the painstaking accounts of muscular and fascial attachments and relations are not revealed in the illustrations—the latter being serviceable only to verify the cruder features and not as reminders of careful laboratory experience: but it can be said that

these myological figures originally untinted, are now less garishly scarlet and therefore more natural, than they were, say in the sixth edition. In the first editions, the arteries were dully the veins too deeply colored in the sixth edition they were deeply colored but diagrammatically clear: now in the general process of toning down pigment, they are not sufficiently clear wherever the background contains a complexity of other structures. In addition, certain of the borrowed figures have been villainously treated both as to reproduction and coloring: elsewhere, obscure specimens of dissections are retained—not old enough to be of historic interest, and too rough to deserve inclusion in a newly revised text: some larger dissections require study before even the experienced can understand them. On the other hand, some new figures added from the authors' dissections, models or diagrams are forcefully clear (and often unique, as one may find for example, in the sections upon the organs of special sense and upon the urogenital system.)

An early edition contained the statement that one criticism upon most of the current textbooks of human anatomy is that they are too extensive for the beginner—a criticism, that is even more applicable now than then, since the curricular time allotted to gross anatomy has been through the years greatly reduced: and yet this work continues, in the traditional manner to be encyclopedic, containing to about one-sixth of its bulk material that is nowadays handled admirably by the separate textbooks of embryology, neurology, and histology.

B. J. ANSON

THE authors divide salivary gland tumors into three categories: (a) epitheliomata (b) mixed tumors, and (c) sarcomata.<sup>2</sup> In their opinion many lesions which in the literature are recorded as sarcomata are actually carcinomata. Most observers will agree with the statement of the authors that it is impossible to predict or detect the point of departure at which a carcinomatous transformation occurs in the epithelium of a mixed tumor of the parotid. The monograph is introduced by an interesting and complete historical review of the subject.

The anatomical pathological discussion concludes with the belief that by far the majority of malignant tumors of the salivary glands are epithelial, the polymorphism of the connective tissue stroma is more apparent than real. There follows an excellent description of the symptoms, signs, clinical course, extension, recurrence, metastases and terminal stages of tumors of the parotid, submaxillary gland and accessory salivary glands.

After an elaborate review of the various methods of treatment pursued by different surgeons and radiotherapists the authors advise extensive radical resection of the primary lesion followed by radical surgical removal of the regional lymphatic glands.

<sup>1</sup>MORRIS' HUMAN ANATOMY: A COMPLETE SYSTEMATIC TREATISE. Edited by C. M. Jackson, M.S., M.D. 9th ed. Philadelphia: P. Blakiston's Son & Co., 1933.

<sup>2</sup>ÉPILOGUE DU CANCER. Directeur: Professeurs H. HARTZMAN et L. BÉARD. Secrétaire: A. CHABOT. CANCER DES GLANDES SALIVAIRES. Par Charles DUBOIS et Jean CREYSEL. Paris: G. Doin & Co., 1932.



followed by postoperative radiation with X-rays or radium. Radium application after operation by means of molds at 2 centimeter distance is preferred by the authors to X ray therapy. In the treatment of carcinoma of the submandibular glands and mixed salivary gland tumors, wide surgical removal followed by postoperative radiation are also recommended.

The authors conclude that modern radium therapy can succeed in eradicating parotid tumors but

the percentage of cures reported is low whereas wide surgical removal followed by radiation yields 40 per cent three year cures.

This monograph constitutes a thorough, comprehensive and authoritative review of the subject and takes its place among the best monographs upon tumors. An extensive bibliography is appended which should prove most useful to anyone specially interested in this field of tumor pathology diagnosis and treatment.

Max Cutler.

## BOOKS RECEIVED

Books received are acknowledged in this department, and each acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

MIXTANLAN UND REISONS IM KNOCHEN BEIM GEMALCARCINOM DER FR U UND IERE DARRSTELLUNG IM ROENTGENBILD. By Dr. L. Philipp and Dr. G. Schaefer. Berlin: Julius Springer, 1933.

ANNUAL CLINICAL REPORT OF THE GOVERNMENT HOSPITAL FOR WOMEN AND CHILDREN, EDINBURGH, MARCH FOR THE YEAR 1933. Medical Government Press, 1933.

AN INTRODUCTION TO THE STUDY OF THE NERVOUS SYSTEM. By E. E. Hewer D.Sc. (Lond.) and G. M. Sanders, F.R.C.S. (Eng.) M.B. B.S. (Lond.) 2d ed. London: William Heinemann (Medical Books) Ltd., 1933.

BRISTOL AND DRIVER'S TEXT BOOK OF PHARMACEUTICAL CHEMISTRY. Revised by John Edmund Driver Ph.D. M.Sc. A.I.C. 2d ed. London: Oxford University Press, 1933.

MASTER MIND AND MEDICINE: THE RISE OF MEN FROM SUPERSTITION TO SCIENCE. By Howard W. Haggard, M.D. New York: Doubleday Doran & Company Inc. 1933.

MATERNAL MORTALITY IN NEW YORK CITY: A STUDY

OF ALL PUERPERAL DEATHS DURING 1930-1931. By the New York Academy of Medicine Committee on Public Health Relations. Ransom S. Hooker M.D. F.A.C.S. Director of Study. New York: The Commonwealth Fund, 1933.

POST-OPERATIVE TREATMENT. By George Sanford Foster M.D. Boston: The Christopher Publishing House, 1933.

GUÍA PRÁCTICA DE ANÁLISIS TERRITORIAL. By José de Mendonça.

BIOLOGÍA Y PATOLOGÍA DE LA MUJER. TRATADO DE OBSTETRICIA Y GINECOLOGÍA, PUBLICADO BAJO LA DIRECCIÓN DE LOS DOCTORES JOSÉ HALBAY Y LUDWIG SEITZ. TOMO XIII. Madrid: Editorial Plus Ultra, 1933.

TRANSACTIONS OF THE AMERICAN PROCTOLOGICAL SOCIETY. THIRTY-FOURTH ANNUAL SESSION HELD IN CHICAGO, ILLINOIS, JUNE 18 AND 19, 1933. Birmingham, Alabama: American Printing Company, 1933.

ALATOS & DISTURBANCES OF THE EYE. Revised and largely rewritten by Frederick Ridley B.Sc., M.B., B.S. F.R.C.S. and Arnold Sorby M.D. F.R.C.S. 4th ed. London: Oxford University Press, 1933.

BACTERIOLOGY FOR MEDICAL STUDENTS AND PRACTITIONERS. By A. D. Gardner D.M., F.R.C.S. London: Oxford University Press, 1933.



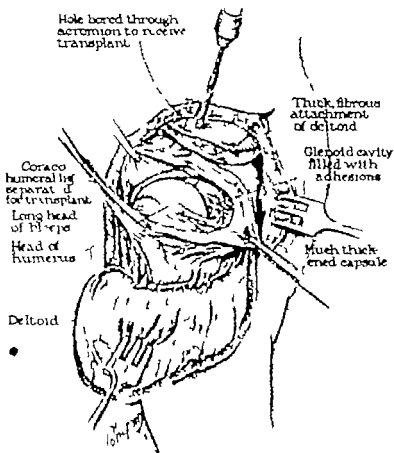


Fig. 4 Capsule incised. Note thickness of capsule and fibrous tissue that obliterates the glenoid cavity—with biceps tendon in anterior portion. Coracohumeral ligament dissected free.

*The Reduction of Old or Irreducible Dislocations of the Shoulder Joint.*—William R. Cubbins James J. Callahan and Carlo S. Scuderi.

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVIII

FEBRUARY, 1934

NUMBER 2

## THE REDUCTION OF OLD OR IRREDUCIBLE DISLOCATIONS OF THE SHOULDER JOINT

WILLIAM R. CUBBINS, B.S., M.D., F.A.C.S., JAMES J. CALLAHAN, B.S., M.D., AND  
CARLO S. SCUDERI, B.S., M.D., CHICAGO

SINCE they were first described in the early works on surgery old and irreducible dislocations of the shoulder joint have been a very difficult problem for surgeons. Improvement in the methods of treatment of these conditions has been very slow for the reason that the injury most commonly occurs in the laboring class and in the ignorant patients who are less likely to have competent surgical help.

It is difficult to understand how a condition so clear cut and with such outstanding symptoms can be overlooked and remain undiagnosed until the condition has become ancient. We will admit that the symptoms may be obscure if the patient is obese in which case diagnosis is dependent entirely upon the physical findings, sometimes even in this type of case a poor roentgenogram taken in an incorrect position may be very misleading. On the whole, however, diagnosis should be rapidly and accurately made and the proper reduction accomplished.

That there are dislocations of the shoulder which cannot be reduced by any manipulative measure is a factor always disputed by the surgeon with an experience limited to 50 to 100 cases. When, however, the surgeon has treated 100 or more patients, he is as a rule ready to admit that there are times when it not only is not possible to reduce the dislo-

tion, but that it is an extremely dangerous step to proceed with the manipulative treatment.

The old literature is filled with reports of rupture of the axillary vessels and injuries to the nerves of the shoulder arm and forearm as well as fractures of the humeral head which later have had to be removed by an open operation. The literature of the days before and to some extent after the advent of aseptic precautions is also filled with the reports of victories over neglected dislocations, by means of manipulative measures, but by and all the surgeon who causes a serious injury in a surgical attempt does not display his error in headlines. We are convinced that a careful open operation is much safer and will produce a higher percentage of good results than can be obtained by manipulative measures which must be done as it were in the dark.

After teaching with cadaveric material the causes of production and the means of reduction of dislocations of the shoulder, one of us was very confident that a manipulative reduction could always be accomplished with safety. A wide clinical experience gained in many years has convinced him, however, that such is not the case. We are therefore ready to state unequivocally that some relatively recent dislocations cannot be reduced by manipulative measures for there is always the great danger

that the function of the arm may be impaired by such measures.

In manipulative procedures no holds or methods are barred provided they are not harmful. We have used Kocher's method the traction method the hammock method and once or twice in spite of our fear and abhorrence have put a heel in the axilla. We believe that of all these measures traction of a firm steady type with the surgeon manipulating while the assistant making the traction varies the line of pull or rotates the limb is by far the safest and most satisfactory method. Many dislocations have been reduced by the Kocher method with speed and safety but there are times when it is not effective. The hammock or suspension method will also fail far more frequently than the steady traction and manipulation.

But this is not a paper designed to deal with manipulative methods—rather it is one desired to describe what we consider to be the safest and most satisfactory method of reducing an old or irreducible dislocation by open operation. As nearly as we have been able to determine and it is far from simple in the bottom of a large oozing wound these dislocations are caused first and most commonly by the firm hold of the long head of the biceps. It does not seem to occupy any very unusual position and in only two cases have we seen it torn from its groove in the humerus never have we seen it torn from the glenoid or ruptured. The head of the biceps simply holds the humeral head firmly until the former has been freed from its groove or slipped forward over the humeral head when out of the groove. But when the head of the biceps is released the humeral head as a rule can be freed immediately. In the cadaver we have found that difficult cases for reduction could be produced by cutting a longitudinal slit in the capsule inferior and slightly anterior then forcing the humeral head down through the slit without causing a wide tear in the capsule. This narrow slit will sometimes hold so firmly that it will require 15 to 20 minutes of expert manipulation before the head can be reduced. But we have not seen or better say have not been able to identify any case of this type in our operative cases. The reason for this may

be that we have made a reduction in the greater number of our cases by the anterior approach which at best gives a very limited view of the injured tissues.

In contrast to the cases which we described as being made with a slit in the lower anterior surface of the capsule we felt reasonably certain that reduction could be easily accomplished in those cases in which great violence had been exerted at the time of the injury and in which the force had continued after the production of the injury so that there had been extensive tendon and muscle destruction. In the vast majority of cases this continues to hold true but in one of our recent cases the patient was operated upon by this new method for a recent dislocation. Great force was one of the causes of the injury and the man had had four different manipulative attempts at reduction under complete anesthesia before open operation was decided upon. In this man's shoulder nearly every ligament had been destroyed except the long head of the biceps and the subscapularis tendon yet reduction could not be accomplished until the biceps tendon had been freed from its groove and slipped forward over the head.

Some of our favorite theories consequently began to fade for example a dislocation in which the violence producing the injury is of only brief duration not having continued long enough to cause the limb to be violently twisted around after the infliction of the initial insult is as a rule difficult to reduce on the other hand a dislocation in which there has been long continued and violent injury with a maximum destruction of the adjacent tissues, is, as a rule easily reduced. We expect that these statements will be criticized but after all they are based on our observations. We have not used the operation of E. Wythe Andrews, although we admit that it gives a very excellent exposure. The objections to it are (1) that it makes a very ugly scar (2) that the tendon of the pectoralis major is not easily handled and it may not hold firmly when sutured (3) that the arm must be dressed at the side and therefore in an elderly person the shoulder is very difficult or impossible to mobilize after a long period of immobilization. Moreover it would be just as

difficult with this approach to force the head into the glenoid cavity without that cavity having been freed of this condition. We have always adhered to the belief that the less trauma connected with a procedure the more nearly perfect will the recovery be, hence we have hesitated to cut the subscapularis tendon after the method of Dollinger and especially as it has been so easy to mobilize the long head of the biceps.

The so called "saber cut incision," by which the acromion is cut off was abandoned, because we wished to preserve the acromion particularly in those cases in which it was advisable to fasten the head of the humerus firmly to it in an abducted position with a strip from the capsule, or with the long tendon of the biceps.

In recent irreducible dislocations in relatively young patients the old incision along the anterior edge of the deltoid may be used, and the head reduced and dressed to the side. This technique has given excellent results but even in these young people when this incision is used, the possibility of a recurrent dislocation or of serious injury to the vessels and nerves must be kept in mind. In older patients however we are certain that the procedure to be described will be preferable, in that it will avoid a long period of disability, decrease the possibility of recurrence and give a perfectly functioning shoulder joint. The conditions encountered in old dislocations are vastly different from those in recent dislocations and we shall try to describe and illustrate the pathological condition found. The upper capsule is, as a rule, thickened (Fig 4). This capsule, combined with the widespread, sheetlike tendons of the supraspinatus and infraspinatus muscles is in some cases about  $\frac{3}{8}$  inch thick. This heavy, thick mass begins with the coracohumeral ligament which constitutes the anterior portion and becomes thicker through the area covered by the supraspinatus and infraspinatus and teres minor tendons. Although the posterior portion of the true capsule is somewhat thinner, still it is about three times its normal thickness. This mass of tendinous tissue described may not be present in all cases, because the tendons may have been

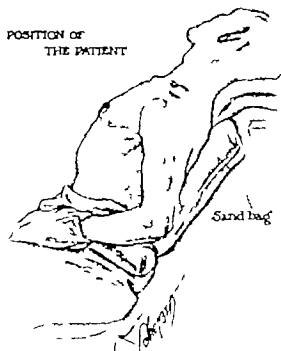


Fig. 1. Position on table with sand bag behind and a little below shoulder.

ruptured at the time of dislocation and have retracted beneath the acromion process or the greater tuberosity may be avulsed and lie over the dislocated head. We have not found the fractured dislocated tuberosity retracted to any great extent, it is nearly always adjacent to the spot from which it has been torn. This is particularly true if the dislocation in which the avulsion occurred has been reduced without unnecessary delay. We have seen detached fragments dislocated up between the humeral head and the glenoid.

The glenoid cavity is narrow and if the dislocation is relatively recent, is filled with a gelatinous material. In older cases this changes to a heavy fibrous tissue that tends to obliterate the cavity of the joint completely (Fig 4). The deltoid muscle is also shortened and shrunk, and the cavity it covers is so narrowed that if the capsule in its thickened and contracted condition, did not block the reduction of the humeral head, the shrunk deltoid could very easily prevent reduction in old cases.

In operating with the incision extending from the clavicle down to the anterior border of the deltoid, we have been forced by these

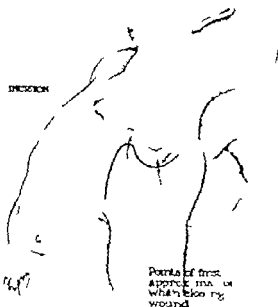


Fig. 2. Incision is made between anteromedial border of the deltoid, and the pectoralis major anterior and medial to dislocated head of the humerus, is extended up to the middle of the clavicle, then around the clavicle, acromion, and 2 inches on the spine of the scapula. Right cross incisions are made at arrow points to aid correct reapproximation of deltoid.

conditions present in the glenoid cavity in addition to the shortening and shrinkage of the deltoid to cut away the posterior portion of the capsule and also to free the attachment of the deltoid from the clavicle, acromion and some of the spine of the scapula before we were able to reduce the head into its normal position. After the head has been reduced in order to keep it in the cavity we have been forced to hold the arm to the side with the elbow somewhat forward—a step we believe to be preferable to resection of the head of the humerus. We have come to believe however that because following this procedure the function of the shoulder joint is extremely limited it would be better to resect the head as has been done by surgeons in this type of case for many years.

It was to overcome these difficulties that we were forced to seek a different method of approach. The method upon which we decided enables us to free the humeral head from its abnormal position with both speed and safety at no time are we in any danger of

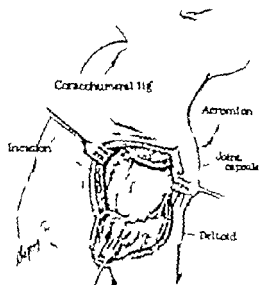


Fig. 3. Deltoid and skin flap reflected down to expose empty glenoid, flattened capsule, and coracoclavicular joint with muscular and tendinous attachments.

injuring the vessels or nerves in any manner no matter how much time has elapsed since the dislocation was produced. And most important we are able to fix the head firmly so that the extremity may be immobilized in the position of salute and at the same time be useful even if ankylosis should occur. We believe also that, with this method of procedure, the freeing of the head the cleaning out of the glenoid and cavity, the fixing of the head to the acromion with a string strip of fascia lata after the method of Henderson—in a dislocation so old that a new glenoid cavity has formed and there is marked loss of function because of pain from pressure and limitation of motion—a better and more useful joint can be obtained. As the glenoid is easily accessible in this approach we would suggest that it might be possible to do some plastic work on the glenoid if it has been too much distorted by the misplaced head. But it must be remembered that any fixation of the humeral head with the biceps tendon a part of the capsule or by the method of Henderson will limit the rotation of the humeral head, the degree of rotation depending on the individual.

We have found that if the patient is placed in a sitting position (Fig. 1) the surgeons

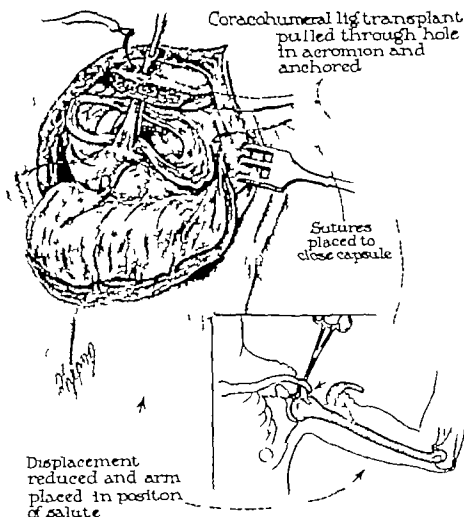


Fig. 5. The coracohumeral ligament is pulled through the drill hole in the acromion for humeral fixation after reduction. Insert shows the position in which the humerus is dressed. The cut edges of the capsule are approximated with catgut sutures.

task becomes less arduous. The anaesthetist is then out of the way and there is good visibility until it is time to close the wound. The fact that the patient's arm is held in the position of salute does make the closure difficult, but closure is even more difficult with the patient reclining. We, therefore, finish the operation with the patient still in the sitting position.

The skin incision (Fig. 2) begins medial to the dislocated head, extends along the anterior border of the deltoid and is carried up to the clavicle, then along the anterior edge of the clavicle around the acromion and back 2 inches along the edge of the scapular spine. Two cross marks are made at the anterior angle and at the posterior angle of the acromion to aid in the correct reapproximation of

the deltoid muscle. The incision is then deepened in front down between the anterior edge of the deltoid and upper border of the pec

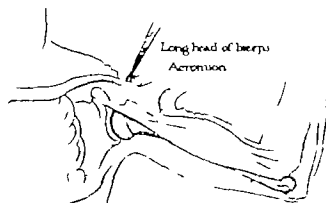


Fig. 6. The position of arm with the humerus fixed in glenoid cavity the long head of biceps being drawn through and attached to the acromion.



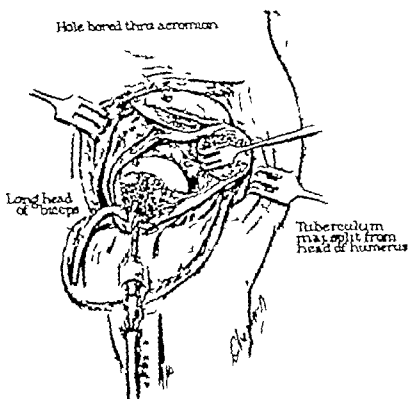


Fig. 7. Exposure of the joint cavity by cutting off the tuberosity major and reflecting it and the capsule. Here the tendon of the biceps is used in the acromion and the tuberosity is sutured down over the tendon with catgut. The fibrous tissue that has formed in the glenoid cavity is shown.

totalis major until the loose tissues are exposed. The deltoid is cut through at its origin which is semi-fibrous, to the clavicle and the acromion and spine of the scapula and the entire mass is reflected downward (Fig. 3). An excellent exposure is thus obtained of the empty glenoid cavity with the capsule and tendons of the supraspinatus, infraspinatus and the teres minor. In some cases, the tendon of the biceps can also be seen.

At this stage of the operation we usually make another attempt to reduce the head and if we are not successful we make an incision through the capsule along the course of the biceps tendon freeing it also from its groove between the tuberosities. We might add that while, at this point in the operation

we have found it possible in all of our cases to free the dislocated head we have not succeeded in returning the head to the glenoid cavity until the capsule is opened. Two methods have been used to accomplish this. In the first, we cut the capsule and accompanying tendons from the major tuberosity well down on the posterior surface of the humerus and retract the capsule with sharp hooks until the joint cavity can be freed of the fibrous tissue (Fig. 4, frontispiece) which may be so dense as almost to obliterate the space. The head is then reduced and the capsule with its tendons is sutured back to the tuberosity with a few fine catgut stitches to hold it in position. A heavy spearpoint needle can usually be driven through the capsule and that portion

of the tendon that remains on the tuberosity, or even through the soft tuberosity itself. If the needle cannot be driven through the tuberosity, one or two small drill holes will give sufficient purchase to hold this tendon in place.

In the second method, we cut off the major tuberosity with a chisel and reflect the entire mass (Fig. 7). While we have not as yet had a great number of cases in which this method has been used and are therefore not yet prepared to say which is the better procedure, we do believe that to incise the capsule transversely about  $\frac{1}{4}$  inch from the major tuberosity will, on the whole, be more satisfactory. We had one case, however, that was difficult to suture correctly.

The question of fixation must be considered before the capsule is closed. Up to the present time we have used the method of Nicola twice, that is, we have cut the long head of the biceps well down toward the muscle belly and have drawn the proximal part through a hole drilled in the tuberosity along the outer edge of the head. The humeral head was then fixed to the acromion with firm catgut stitches placed through the capsule or through the bone.

In 1 case we fixed the humeral head by drawing the long head of the biceps through a tunnel in the humeral head and up through the acromion process (Fig. 7). In one instance we attempted to take a slip of the coracohumeral ligament and pass it through the acromion but through an error we were forced to use the biceps tendon (Fig. 7). We are convinced, however, that this slip of the coracohumeral ligament can be used and that if correctly inserted will be successful. There is no question that the method of Henderson can be safely used and that it will certainly give a very stable support. We have been a little reluctant to make a second incision if it could be avoided. If one does wish to use the Henderson technique we would suggest that a good plan would be to free the fascial strip first and allow it to remain in its normal bed

until the shoulder wound is ready for its use. If this is done the time necessary to keep the major wound open is shortened.

As previously mentioned, before the skin is incised small transverse lines are made at two points in the curve so that the muscle and skin may be accurately approximated. If these points are now located and the anterior portion of the deltoid is sutured to the cervical fascia at the first point and the posterior portion at the second corresponding mark the muscle will fit nicely in place. With three additional sutures that will merely approximate the wound edges—it is not necessary to try to sew the edges together—time can be saved and an excellent union of the muscle obtained. We use silk and skin clips to approximate the skin edges but the operator may prefer some other method.

The arm is dressed in the position of salute and is held in position in a cast, for 4 to 6 weeks. When the cast is first removed it should be taken off carefully so that after passive and active motion it can be replaced and worn until the patient becomes accustomed to motion and is able to hold the arm in the normal position. As a rule these first motions have been very painful.

#### SUMMARY

1. An incision that separates the deltoid from its origin and allows it to be displaced downward, makes possible a safe approach to practically any shoulder joint condition.

2. The incision described is preferable to the saber cut incision which separates the acromion from its attachment for it saves the acromion which can be used to retain the humeral head in position.

3. The incision gives better access, and a more serviceable joint than the Andrews incision which divides the pectoralis major tendon.

4. If the deltoid is accurately approximated as described its function will not be disturbed in the least.

5. The scar causes very little, if any, disfigurement.

## EXPERIMENTAL STUDY OF THE EFFECT OF HISTAMINE ON THE HEALING OF GASTRIC DEFECTS—ARTIFICIAL GASTRIC ULCER

CHARLES A. FLOOD, M.D. AND EDWARD L. HOWES, M.D. NEW YORK

From the Departments of Medicine and Surgery, College of Physicians and Surgeons, Columbia University, New York

THE cause of the chronicity of peptic ulcer in man is still problematic. Many experimental methods have been devised for producing acute gastric ulcers in animals, but comparatively few ways are available for rendering an acute ulcer chronic.

A number of workers have attempted to prevent the healing of experimental ulcers by the introduction of hydrochloric acid through a stomach tube. Matthes found that 350 cubic centimeters of 0.56 per cent hydrochloric acid introduced daily into a dog's stomach delayed the healing of an artificial defect in the mucosa as compared with a control dog. The same procedure was repeated by Littauer who used 0.37 per cent hydrochloric acid. He also ligated some of the vessels supplying the area in the stomach where the defect was made. One of 5 animals showed a delay in healing when sacrificed after a period of several weeks. Previously Fibich had reported that ligation of some of the gastric vessels and removal of the corresponding mucosa resulted in gastric ulcer. Littauer was unable to confirm this finding.

Marked anemia has been found to cause some delay in the healing of experimental ulcers. Quincke and Daetwyler destroyed areas of gastric mucosa of the dog's stomach by various means and noted that these areas healed more slowly if the animals were made anemic by venesection. The same type of experiment was repeated and confirmed by Silbermann who used subcutaneous injections of pyrogallic acid in place of venesection to produce the anemia.

The injection of peptone intravenously and subcutaneously was reported by Turck to cause delayed healing of ulcers in 2 of 6 dogs. This has not been confirmed. A possible histamine-like effect of the peptone is of interest in connection with the present study.

Friedman and Hamburger studied the influence of pyloric stenosis produced by par-

tial constriction of the pylorus with a ligature on the healing of artificial gastric defects. The stomach became enormously dilated as a result of this procedure and the defects remained unhealed from 4 to 9½ weeks. They attributed the delay in healing to hyperacidity and fermentation. Bolton was also able to delay the healing of ulcers produced with gastrototoxic sera by the same type of procedure.

The ability of a foreign body to interfere with the healing of gastric ulcer was shown by Dragstedt and Vaughan. By cauterizing the stomach with silver nitrate and introducing non-absorbable suture material into the damaged area they were able to keep ulcers open for 3 to 4 months.

Askaniazy has championed the *Oldium albicans* often found in the base of human peptic ulcers as the cause of the latter. He introduced cultures of this fungus into the stomachs of guinea pigs and rabbits in which artificial defects had been produced and obtained chronic ulcers of several months duration in some animals. However, Kirch and Stahnke were unsuccessful in delaying the healing of lesions in the dog's stomach by covering them with pure cultures of *Oldium albicans*.

Morton, utilizing the technique of Mann for surgical duodenal drainage, studied the effect of preventing duodenal reflux in this manner on the healing of artificial gastric defects. He obtained ulcers which were chronic in appearance and remained open for as long as 3 months. The ulcers which were placed high in the fundus healed more readily than those near the pylorus.

Bahat and Weiss offered the hypothesis that chronic ulceration in various parts of the body is due to low grade acidosis. They found that the intravenous administration of sodium acid phosphate, daily, tended to prevent the healing of mucosal defects in the dog's stomach.

and they attributed this result to changes in the hydrogen ion concentration of the blood. Their results have not been confirmed.

Recently interest has been aroused in the action of histamine in delaying the healing of experimental lesions of the stomach. McIlroy cauterized the wall of the cat's stomach and then administered 10 to 20 milligrams of histamine subcutaneously every other day. At the end of 8 to 15 days, there was an extension of the original lesion. O'Shaughnessy obtained chronic looking ulcers in two of a series of cats by injecting the drug locally into the wall of the stomach and subsequently giving very large doses subcutaneously. Friedenwald, Feldman and Morrison injected 1 per cent hydrochloric acid into the stomach wall and then gave 0.5 milligram of histamine one to three times a day. They concluded that the histamine as given had no effect on healing.

#### CHIEF METHODS FOR DELAYING HEALING OF MUCOSAL DEFECTS IN STOMACH

Method	Author	Year	Animal used
14% HCl by stomach tube	Matthos	893	Dog
37% HCl by stomach tube	Littauer	900	Dog
Azemia produced by resection	Quincke & Dextwyler	88	Dog
Azemia produced with pyrogastric acid	Silbermann	886	Dog
Injections of pepsine	Tierck	1906	Dog
Partial pyloric stenosis	Friedman & Hasenberger	104	Dog
Non-absorbable suture in floor of defect	Drapatz & Vagstad	924	Dog
Surgical cholecystic drainage	Morton	1917	Dog
Old-time ulcers	Aukerman	1924	Rabbit, Guinea pig
Sodium acid phosphate intravenously	Ballot & Vass	917	Dog
Subcutaneous injection of histamine	McIlroy	1928	Cat

In our experiments we have studied the influence of various doses of histamine on the healing of mucosal defects in the stomach of the cat and dog. These defects were cut with a sharp scalpel so that the amount of tissue destruction was definite. In some of the experiments previously mentioned chemicals or the cautery were used and the amount of destruction of tissue was indeterminable.

#### METHODS

Full grown cats from 2.8 to 4 kilograms in weight and dogs ranging from 12 to 16 kilograms in weight were used. Artificial defects were produced in the mucosa of the stomach. Two areas of the stomach were chosen for study: one on the lesser curvature or posterior surface 1 to 3 centimeters from the pylorus and the other high in the fundus on the greater curvature 4 to 8 centimeters from the cardiac orifice. Under ether anesthesia the abdomen was opened and the stomach incised longitudinally through its anterior surface at about the junction of the middle and lower thirds. The site selected for the defect was then grasped with a clamp, evaginated through the incision and stretched out flat. An area of mucosa measuring approximately one square centimeter was then excised. The surface of the resulting defect was usually scarified lightly in criss cross fashion with a scalpel. In a few instances this was not done. Originally it was intended to make tracings of the defects and measure their size at the beginning and end of each experiment, but the variable state of contraction of the stomach rendered this procedure inaccurate and the plan was, therefore, abandoned.

The subcutaneous administration of histamine<sup>1</sup> was started on the day following operation and continued until the animal was chloroformed. Most of the animals were fed on the routine laboratory diet. For the cats this consisted of milk, meat and vegetables and for the dogs meat, bread, and vegetables. A few cats received salmon in addition. The food was given at noon and taken away on the following morning. As a rule the cats ate intermittently and the amount of food eaten in a given period of the day could not be controlled. At autopsy the stomach was removed distended with Jores solution and opened after fixation.

#### RESULTS

1. *Effective dose of histamine for interfering with the healing of a prepyloric lesion in the cat.* The influence of various doses of histamine on the healing of prepyloric mucosal defects was studied in a series of 26 cats. The amounts of histamine and the effect on the

<sup>1</sup> Ergamine acid phosphate, Burroughs-Wellcome and Company.

TABLE I—EFFECT OF HISTAMINE ON PREPYLORIC MUCOSAL DEFECT IN THE CAT

Number	Histamine mg per kilo	Duration days	Macroscopic interference with healing
1600	b d	7	No
794	6 b d	7	No
7	9 b d	7	Yes
954	b d	7	Yes
1978	b d	6	Yes
1900	b d		Yes
994	b d	6	Perforation
1649	4 b d	7	Yes
79	5 b d	7	Yes
113	8 b d	10	Perforation
79	5 b d	7	Yes
13	6 b d	5	Death due to toxicity of histamine?
734	6 b d	1	
998	b d		Yes
173	d	7	No
993	d	7	No
1957	d	7	Yes
87	d	7	Yes
918	d		No
911	5 d	14	Yes
81	3 d	7	Perforation
81	1 d	7	Yes
830	3 d	7	Yes
110	4 d	7	No
797	3 d	7	Yes
175	5 d	7	Yes
1798	5 d	7	Yes

gross appearance of the lesions is summarized in Table I. Twelve animals received the drug twice a day in doses ranging from 0.23 to 1.6 milligrams per kilogram. They were sacrificed after periods of 6 to 14 days. When the dose in this group exceeded 0.9 milligram per kilogram definite interference with healing could be seen in the gross appearance of the lesion. A detailed description of the pathological findings is given below. An alteration in the picture of healing was evident microscopically with smaller amounts of histamine and was seen with a dose of only 0.23 milligram per kilogram twice a day.

Another group of 8 animals in this series received histamine once a day. The amounts given ranged from 1.2 to 3.0 milligrams per

TABLE II—EFFECT OF HISTAMINE ON MUCOSAL DEFECTS HIGH ON GREATER CURVATURE

Number	Histamine mg per kilo	Duration days	Macroscopic interference with healing
1439	20 b d	6	No
1719	b d	7	No
1996	b d	7	Yes
79	5 b d	7	No
179	8 b d	7	No
993	d	7	No
9957	d	7	No
911	5 d		No
830	3 d	7	No

kilogram. Doses of 2.0 milligrams per kilogram or more caused a definite interference with healing as judged both grossly and microscopically, whereas 1.2 milligrams per kilogram had no apparent effect.

Three animals with prepyloric defects received four doses of the drug per day. The amount given to each was 0.15 milligram per kilogram twice in the morning and twice in the afternoon, each pair of doses being given a half hour apart. At the end of 7 days all showed marked interference with healing.

Although a given dose of histamine may cause considerable distortion in healing as seen after one week, at the end of 2 weeks, healing may nevertheless occur. If the dose is sufficiently large, however, the lesion will remain open for 2 weeks. To prevent healing for at least 2 weeks, 1.2 milligrams per kilogram twice a day was found to be effective. With a dose of 2.5 milligrams per kilogram once a day, healing was not complete at the end of 2 weeks although epithelialization was taking place.

II *The influence of histamine on the healing of a lesion high on the greater curvature of the cat's stomach.* The effect of histamine on the healing of mucosal defects on the greater curvature, high in the fundus of the stomach was studied in 8 cats. Most of these animals also had prepyloric lesions. The doses of histamine ranged from 0.79 to 1.5 milligrams per kilogram twice a day and 2.0 to 3.0 milligrams per kilogram once a day. The results are given in Table II. In general no delay of healing was found grossly or microscopically.

IMPIRE LABORATORY SUPPLY CO. Inc.  
 125 West 13th Street NEW YORK, N. Y.

IMPIRE LAB  
 11930  
 125 West 13th Street  
 NEW YORK, N. Y.

11930

LY CO. Inc.  
 125 West 13th Street  
 NEW YORK, N. Y.

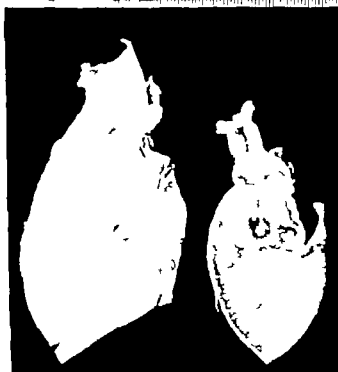


Fig. 1. Prepyloric defects in the cat 1 week after operation. One animal (specimen on right) received 1.5 milligrams per kilogram twice a day. The other received none.

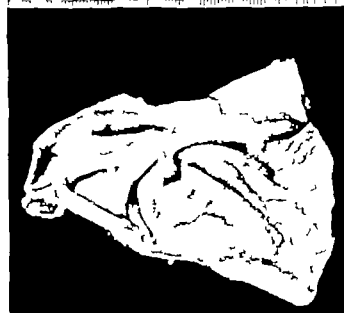


Fig. 2. Prepyloric defect in the cat. Histamine 1.5 milligrams per kilogram twice a day for 2 weeks. Note roughening of gastric mucosa.

with the smaller doses. Neither did the greater number of cats receiving large doses of the drug show a delay in healing. However, one animal which received 1.1 milligrams per kilogram twice a day for 7 days showed definite interference with healing grossly while another which received 1.5 milligrams twice a day showed microscopic evidence of delayed healing at the end of the same period of time. This tendency of the mucosal defect near the cardia to heal even though the prepyloric lesion in the same cat showed delay in healing was apparent in practically all the animals.

III *The effect of histamine on the healing of a mucosal defect near the pylorus of the dog's stomach.* Three dogs were used in all. Defects 2 centimeters square were made in the stomach near the pylorus. One dog served as a control. Another received 0.6 milligram of histamine per kilogram three times a day. At the end of a week the animal was killed and the defect showed normal healing both grossly and microscopically. The third dog

received 1.3 milligrams per kilogram twice a day. The defect in this animal showed the same type of interference with healing at the end of a week as occurred in the stomach of the cat with the same relative dose of histamine.

#### PATHOLOGY

I *Healing of prepyloric mucosal defect in control animals.* The normal healing of the prepyloric mucosal defect of the cat was studied in 6 controls. Grossly after 1 week the defect was found to be rounded measuring about one-quarter of the original size and the edges were smooth and not indurated. The floor was covered with granulation tissue and was almost flush with the surrounding mucosa. Histologically new epithelium was seen growing across the ulcer. Its cells were flattened out. In the center, the surface was covered with only a little or no necrotic debris. At the edges of the original defect the new epithelium was columnar and the masses of cells dipped downward to form cyst like structures suggesting newly forming gastric glands. Beneath the regenerating epithelium there was a moderate proliferation of granulation tissue and a few wandering cells were present.



Fig. 3. Perforated prepyloric ulcer in the cat. Histamine 5 m. 1/2 grains per kilogram twice a day for 10 days.

At 2 weeks the prepyloric lesion was healed and was represented by only a small puckered area in the mucosa covered by new epithelium.

**II. Effect of histamine upon prepyloric mucosal defects.**—Roughly the prepyloric defect after 1 week of an adequate amount of histamine appeared very different from the control. It was larger, having contracted to only about one-half its original size. It was usually oval in shape with its longer diameter corresponding to the long axis of the stomach. The edges were elevated and indurated and the floor was deeper and covered with a brown or greyish slough. Sometimes, however, the defect maintained its original shape and aside from some diminution in size and increase in the amount of induration showed little alteration from the original appearance produced at operation.

At 2 weeks the defect was smaller, the induration was more marked, but the floor was shallower and epithelium was growing in from the edges.

Microscopically at 1 week the surface of the prepyloric ulcer was always covered with a layer of exudate, consisting of necrotic material in which fibrin pyknotic nuclei of polymorphonuclear leucocytes, and a few desquamated epithelial cells were identified. Beneath this exudate there was granulation



Fig. 4. Indurated prepyloric lesion in the dog. Histamine 2 m. 1/2 grains per kilogram twice a day for 7 days.

tissue. The latter had filled in the areas where the muscularis was scarified and was growing upward into the lower layer of the exudate on the surface. No alteration was seen in the blood vessels at the periphery. The edges of the ulcer were steep and covered with epithelium which often turned downward to form a trough. The epithelium was arrested where it had reached the exudate on the surface. Sometimes it grew downward in the substance of the submucosa. The cells contained frequent mitotic figures. The gastric glands at the edges of the ulcer were sometimes increased in length and the stroma between them appeared slightly ordematous, sometimes moderately infiltrated with a number of lymphocytes. The cut edges of the muscularis mucosae were curved down and backward. In the submucosa beneath the edges of the ulcer there was usually a proliferation of granulation tissue accounting for the induration noted in the gross specimen.

The extent of these changes described was in proportion to the amount of histamine



Fig. 5. Prepyloric defect in the cat, 7 days after operation. No histamine. Normal healing



Fig. 6. Prepyloric defect in the cat, 7 days after operation. Animal received 0.25 milligram per kilogram of histamine twice a day

given and the frequency of its administration. With the larger more frequently administered doses, the amount of necrotic exudate was most abundant and healing correspondingly retarded. With the smaller doses there was relatively little necrosis but instead an excessive proliferation of granulation tissue.

After 2 weeks of the larger doses of histamine there was less slough on the surface of the ulcer and the granulations were filling in the defect. Flattened out new epithelium was beginning to grow across the surface.

Perforation occurred in 3 animals death resulting on the fifth, seventh and tenth

days respectively, from acute diffuse peritonitis. The ulcers in these instances were funnel shaped with steep edges. The floor of the ulcer presented a punched-out appearance and the edges were markedly indurated.

*III Mucosal defects high on the greater curvature of the stomach.* The repair of the control defects high in this area took place a little more rapidly than it did in the control lesions situated at the prepyloric region. With histamine the gross and histological pictures of healing in this locality could not be differentiated from the controls in most





Fig. 7. Prepyloric defect in the cat, 7 days after operation. Histamine 0.0 milligram per kilogram twice a day. Interference with healing.



Fig. 8. Prepyloric defect in the cat. Animal received 1 milligram of histamine per kilogram twice a day for a week.

instances. A few lesions, however, presented the same characteristics of delayed healing described for the prepyloric lesions, but to a lesser degree. Those with delayed healing were described grossly.

*Effect of histamine on the intact gastric mucosa of the cat.* Erosions of the gastric mucosa have been reported following prolonged administration of histamine in various animals. Buechner Siebert and Molloy found gastric

erosions in a large percentage of rats receiving histamine. These animals were starved every other day. The lesions occurred chiefly in that portion of the stomach lined with squamous epithelium. They were really areas of epithelial hyperplasia with eroded surfaces. Matsueda also reported the occurrence of ulcerative lesions in the stomachs of guinea pigs, rabbits and dogs after large doses of histamine given for a number of weeks. He

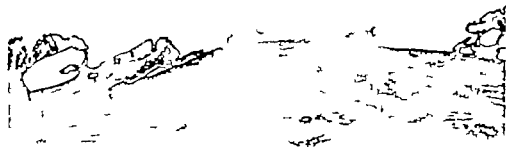


Fig 9. Mucosal defect high on the greater curvature of the cat's stomach after 15 milligrams of histamine per kilogram twice a day for a week. Histamine has little effect upon healing in this region.

did not describe the type of diet given to these animals

We obtained gastric erosions following the injections of histamine in only 1 animal in this series. Several though had a few erosions at the lower end of the esophagus but not in the stomach. The gastric mucosa, after distention and fixation, was usually smooth and similar in appearance to the controls. However the stomachs of 6 cats receiving histamine did show striking changes in their gross appearance of a different nature. The surfaces of these stomachs were mottled with whitish, elevated streaks. The mucosa was roughened and leathery in texture. Some times, in addition, there were marked mamelonnations. These changes involved both the antrum and the fundus of the stomach and are best shown in the accompanying picture. The amount of histamine administered to each animal which presented this finding is given in Table III.

#### SUMMARY

The action of histamine has recently been completely reviewed by Best and McHenry and does not need further elaboration here. An explanation of the mechanism of the delay of healing after the administration of histamine awaits further investigation.

Histamine was found to cause a pronounced change in the healing of artificial mucosal defects in the prepyloric region of the stomachs of the cat and dog. There was increased destruction of tissue in the floor of the ulcer. The mucosal epithelium did not grow across the surface of the defect so rapidly as in the controls. When healing did begin, connective

tissue proliferation took place in excessive amount in the floor and edges of the ulcer, resulting in induration of the lesion. The extent of the delay of healing was proportional to the amount of histamine given. The amount of the drug which must be given in order to delay the healing of a mucosal defect of approximately 1 square centimeter for 2 weeks was in the neighborhood of 1 to 1.2 milligrams per kilogram twice a day. Doses appreciably less than this interfered with healing but had little effect on the length of healing time of the lesions of this size.

The administration of doses of histamine larger than 1 to 1.2 milligrams per kilogram twice a day was prohibited by the toxic symptoms resulting. McIlroy who used 10 to 20 milligrams every other day for the cat did not mention toxic symptoms. In our experience this amount of histamine caused violent vomiting, salivation, and passage of watery stools within a few minutes after injection of the drug. The animals lost appetite and weight. Two cats in the present study receiving 1.6 milligrams per kilogram twice a day

TABLE III.—CATS WHICH PRESENTED GROSS ALTERATION IN THE APPEARANCE OF THE GASTRIC MUCOSA

Number	Histamine per kilogram	Duration—days
956	1 b.d.	7
900	2 b.d.	4
703	1.5 b.d.	7
87	2 o.o.d.	7
181	3 o.o.d.	7
1767	2.5 4 l.d.	7

presented these symptoms and died after 3 to 5 days. At autopsy no cause of death was found and death was attributed to the toxicity of the drug. Doses of 3.0 milligrams once a day also produced vomiting. These symptoms were usually avoided or were minimal with 1 to 1.2 milligrams twice a day although vomiting did occur occasionally with this amount.

Histamine had little effect in delaying the healing of mucosal defects high on the greater curvature. In a few instances however it caused to a lesser extent the same changes found regularly in the prepyloric region. This capacity of the lesion high on the greater curvature to heal as contrasted to the delay in healing of the lesion in the prepyloric region is of interest because of the infrequency of chronic gastric ulcers high on the greater curvature in man. It is of interest also that despite the profound necrosis resulting from an adequate dose of histamine these lesions finally healed. Apparently the necrotizing agent was diminished in amount or potency or the factors inhibiting its action were increased as time passed. That the balance in favor of healing was not always established however was demonstrated by the three instances in which perforation of the remaining stomach wall occurred.

Finally in a minority of animals, histamine caused an alteration in the gross appearance of the stomach, suggesting a gastritis. Further study on this finding is in progress.

#### CONCLUSIONS

1. The subcutaneous administration of histamine interfered with the healing of a mucosal defect in the prepyloric portion of the stomach of the cat and dog. It delayed

but did not prevent healing in this region of the stomach.

2. Histamine had little effect on the healing of a mucosal defect high on the greater curvature of the stomach.

3. The effect of repeated doses of histamine upon the appearance of the mucosa of the stomach is described.

4. The amount of histamine required to delay the healing of a prepyloric mucosal defect in the cat for 2 weeks is 1 to 1.2 milligrams per kilogram twice a day.

#### BIBLIOGRAPHY

- ARRAZAVI, M. Arch. f. path. Anat. 1924, ccl, 370.
- BALLET, R. and WAINE, S. Gewebeproliferation und Sauerhaasengleichgewicht. Berlin and Vienna. Julius Springer 1930.
- BEST, C. H. and McHENRY, E. W. Physiol. Rev. 1931, xi, 37.
- BOLTON, C. Ulcer of the Stomach. London. Edward Arnold, 1913.
- BOLCHNER, F., SIEBERT, P. and MORLOV, P. J. Beitr. z. path. Anat. u. allg. Path., 1928-1929, lxvii, 391.
- DRABETZ, L. R. and VAUGHAN, A. M. Arch. Surg. 1924, lviii, 79.
- FIRCH, R. Arch. f. klin. Chir. 1906, lxxix, 900.
- FRITZDORF, J., FELDMAN, M. and MORSEY, S. J. Exper. Med. 1935, lvi, 805.
- FRIDMAN, J. C. and HAMBURGER, W. W. J. Am. M. Ass. 9 4, 1931, 350.
- KIRCH, E. and STAMMER, E. MHL. d. Grenzgeb. d. Med. u. Chir. 1923, xxxvi, 174.
- LEITZNER, M. Arch. f. path. Anat., 1909, cxcv, 37.
- MANN, T. and WILLIAMSON, C. S. Ann. Surg. 1923, lvi, 409.
- MATTHEWS, A. Klin. Wchnschr. 1931, x, 1965.
- MATTHEWS, M. Beitr. z. path. Anat. u. allg. Path. 1893, xiii, 300.
- McHENRY, P. T. Proc. Soc. Exper. Biol. & Med. 1927-1928, xiv, 368.
- MORTON, C. B. Ann. Surg. 1927, lxxv, 307.
- O'SHAUGHNESSY, L. Lancet, 1931, i, 177.
- QUINCKE and D. STWYLER. Deutsche med. Wchnschr. 1883, viii, 6.
- SALZEMANN, O. Deutsche med. Wchnschr. 1886, xii, 407.
- TURCK, F. B. J. Am. M. Ass. 1906, xlv, 1755.

HISTOPATHOLOGY OF ANAL CRYPTS<sup>1</sup>

CLAUDE C. TUCKER, M.D., AND C. ALEXANDER HELLWIG, M.D., WICHITA, KANSAS

From the Department of Surgery and the Laboratory of Surgical Pathology St. Francis Hospital, Wichita

**I**NFECTION of the anal crypts is according to Rankin, Bergen and Bue the principal cause of anal fistula. Spastic conditions of the sphincter, periproctitic abscess and hemorrhoids. Not only these local conditions which actually constitute the majority of anal diseases are attributed to the inflammation of the crypts of Morgagni. In a recent paper, Hirschman called the attention to the important rôle that infected crypts may play in producing general symptoms such as neuralgia, muscular pains, headaches, insomnia and certain skin eruptions. In his opinion anal cryptitis is probably the most frequently overlooked source of focal infection that is present in the human body today.

While the clinical importance of infected anal crypts is generally admitted, histological data on this common disease are surprisingly meager. Current descriptions of anal cryptitis as presented in the surgical literature are obviously based only on clinical and macroscopic observations. According to Rankin, Bergen and Bue the Morgagni crypts are surrounded by lymphoid tissue and are susceptible to all traumatic influences which attack the rectal outlet. Anything which produces a break in the tissues about the anal crypts with subsequent admission of pyogenic bacteria may result in infection of these crypts. Thus the infected crypts become oedematous in the opinion of these authors and the papillae become inflamed and adherent over the crypts. This nidus of infection is the beginning of anal fistula.

Hirschman describes the crypts of Morgagni as openings in the mucous membrane of the anal canal usually crowned by small papillae. When diseased these crypts are red and the papillae are pinkish white, enlarged and elongated, sometimes polypoid. Hirschman could often demonstrate pus in the crypts and not infrequently a sinus or a blind fistula was found leading from a diseased crypt. These sinuses varied in length from 1 to 5 centimeters

and extended in a radial direction from the crypts.

Since we were unable to find in the available literature any detailed microscopic description of the lesions causing the clinical picture of anal cryptitis, we studied histologically 331 hemorrhoids and 89 infected crypts removed at St. Francis Hospital. It was hoped that these examinations might furnish a solid basis for the understanding and treatment of this common disease.

The first and most unexpected result of our studies was the observation that in uncomplicated cases of so called cryptitis the mucosa of the Morgagni crypts proper was not the primary seat of the infection but was usually normal. Without exception our specimens showed that the pathological process had its origin in narrow duct like structures which opened into the crypts of Morgagni (Fig. 1). They were either simple tubules (Fig. 2) or complex branching ducts (Fig. 3) which extended from the mucosa of the anal crypts passed into or through the muscular coat of the bowel, and ended blindly in the connective tissue.

In acute infection the lumen of these tubular structures was filled with pus cells and the wall was infiltrated with neutrophile leucocytes (Fig. 4). In subacute or chronic cases the wall of the ducts was formed by granulation tissue or dense fibrous tissue infiltrated with round cells and wandering cells (Fig. 5). That these infected tubules were not fistulous tracts caused by burrowing of an inflammatory process from the anal crypts into the tissue adjacent to the anal canal was evidenced by the presence of epithelial cells lining parts of these ducts. There were stratified squamous cells in the wall near the opening of the duct deeper inward the lining changed to transitional epithelium and finally to columnar epithelium in two or more layers. In several infected ducts a layer of columnar cells was present only in their blind ends.



Fig. 1. Left. Primary lesion of purulent infection of anal duct. Destruction of the epithelial lining in the blind end of one branch of duct is clearly shown. Beginning leucocytosis.



Fig. 2. Preformed tubular anal duct without inflammatory changes. J.C. Morgagni crypt.



Fig. 3. Left. Branching anal duct opening into Morgagni crypt. U.C. without inflammation.

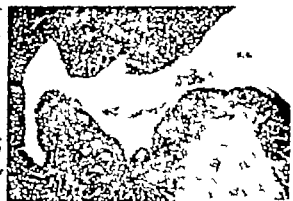


Fig. 4. Acutely inflamed anal duct. The epithelial lining

of the duct is completely destroyed except in the blind end. Leucocytes are infiltrating the wall of the duct and are found within the lumen.

while the other portions of the wall were entirely devoid of epithelium.

The form of these anal ducts, especially that of the branching variety, resembled so closely that of excretory ducts of glandular origin that it seemed unlikely that these structures were the result of an ulcerous process burrowing from the Morgagni crypts into the surrounding tissue. By examining surgical and postmortem specimens of cases without inflammatory changes, we were able to demonstrate in most instances well developed tubular structures which run from the Morgagni crypts into the submucosa and sometimes into the internal sphincter muscle. In no case however were we able to find in human material true glandular tissue in connection with

these ducts. Only in a few ducts were clear cells present in the epithelial lining. The nucleus of these cells was basally located and the high protoplasm was filled with a clear secretory material (Fig. 6). The latter did not give the reaction of mucin. That these anal ducts were preformed and not inflammatory products was further proved by the demonstration of the same structures in human newborn and in the fetus (Fig. 7).

To obtain more information about the biological significance of these ducts, we examined histologically the anal region of rabbits, guinea pigs, cats and dogs. In cat (Fig. 8) and dog (Fig. 9), the same anatomical structures were found but they were more fully developed than in man. In both species, the



Fig. 5 left. Anal duct from a case of recurrent so called cryptitis. Large areas of the duct wall are entirely devoid of epithelium. Regenerating squamous epithelium is shown

creeping into the duct from the crypt of Morgagni, *M C*  
Fig. 6 Transverse section of normal anal duct. Group of clear cells, filled with secretion, in the epithelial wall.



Fig. 7 left. Well developed anal duct in 4 month fetus.  
Fig. 8. Anal region of newborn cat. Glandular organ be-

tween internal and external sphincter muscle. Excretory duct opens into crypt of Morgagni *M C*



Fig. 9. left. The anal canal of a dog. The anal ducts extend from the Morgagni crypt, *M C* into the internal sphincter muscle.

Fig. 10. Anal region of the rabbit. Large alveolotubular gland in external sphincter muscle. Excretory duct communicates with crypt of Morgagni, *M C*

anal ducts communicated with definite though scanty glandular acini which were lying within the fibers of the internal sphincter or between internal and external sphincter muscle. The excretory ducts of these glands resembled in form and epithelial lining exactly those found in man. In the rabbit (Fig 10) a very voluminous alveolotubular gland was found within the external sphincter muscle. It consisted of many lobules the acini were formed by columnar cells and the lumina contained a light stained material which did not give the reaction of mucin. We are unable to say anything definite about the chemical composition of the fluid secreted by these anal glands and we do not know whether these glands of the rabbit produce a lubricant to the feces just before their extrusion from the anal canal or whether they are small glands which fulfill some function in sex attraction. Since in the rabbit and the other species examined the excretory ducts of these glands opened into the same region as in man the conclusion seems justified that the anal ducts in man are remains of complex glandular organs as they are found in the lower orders of mammals.

The question has often been raised why we have inflammatory processes so frequently in and about the anal canal. We believe that our findings of preformed narrow tubular structures in this region explain the frequency of anal infection. Communicating as they do with the bowel lumen these anal ducts afford a ready path for infective organism such as colon bacillus proteus, staphylococcus streptococcus and so forth. Length and direction of these anal ducts which we regard as remains of complex glandular organs determine in our opinion the extension of an anal infection. Bacteria may easily penetrate as we have seen in our specimens through small defects in the epithelial lining of these ducts and gain entrance into the surrounding muscular or fibrous tissue. By burrowing from there into the ischio-rectal fat tissue the purulent process may lead to an abscess in this region. By perforation of the suppurative through the mucosa or epidermis, a complete internal or external anal fistula may result.

The existence of preformed epithelial tubules explains furthermore the clinical fact

that so called cryptitis and anal fistula do not heal as a rule by conservative therapeutic measures. Since in most inflamed anal ducts small areas of the interior epithelial lining are preserved regeneration of the epithelial wall will take place after subsidence of the infection and will prevent obliteration of the ducts by scar tissue. The ducts will thus stay open and give entrance to recurrent infection. It is a common experience that with fistulous epithelial tracts in any region of the body complete healing will not occur as long as part of the epithelial lining remains and that the whole tract has to be removed to obtain a permanent cure.

It seems surprising that these interesting and from a pathogenic standpoint important structures have been almost completely overlooked in the recent literature. In the modern American proctological literature where the subject of infected anal crypts is widely discussed the presence of these ducts is not suspected. There are very few references in the European literature. Herrmann in 1880 described these anal ducts in a beautifully illustrated thesis as normal findings in the dissecting room. In 1902 Tavel reported a case of recurrent purulent periproctitis which he attributed to infection of ducts and cysts found in the surroundings of the anal canal. In the last 30 years only one brief mention is made of these structures, namely by Lockhart Mummery in the *Proceedings of the Royal Society of Medicine* 1929 who regards infection of these normally present glandular ducts as one of the many causes of anal fistula.

#### SUMMARY

1. Histological study of 331 surgically removed hemorrhoids and 89 infected anal crypts revealed the presence of preformed anal ducts which opened into the crypts of Morgagni.

2. These ducts are regarded as remains of complex glandular organs as found in the lower orders of mammals.

3. The narrow tubular structures afford a ready path for infective organism communicating as they do with the bowel lumen.

4. So called cryptitis, anal fistula, periproctitic abscess have their origin in these pre-

formed anal ducts. Length and direction of these structures determine the extension of an anal infection.

5. The existence of preformed epithelial tubules extending from the anal canal into the surrounding tissue explains the frequency of anal infection and the clinical fact that so called cryptitis and anal fistula do not heal as a rule when the method of treatment which

is carried out consists of conservative therapeutic measures.

#### BIBLIOGRAPHY

1. HERDMANN G. *J de l'odont et physiol* 1880, xvi 434.
2. HIRSCHMAN L. J. *J Am. M. Ass.*, 1931 xcvi, 1609.
3. LOCKHART MUMMERY J. P. *Proc. Roy. Soc. Med.* 1929, xiii, 33.
4. RANKIN F. W., BARGEN J. A. AND BUTZ, L. A. *The Colon, Rectum and Anus*. Philadelphia and London W. B. Saunders Co., 1932.
5. TAVEL, E. *Deutsche Zschr f Chir* 1902 lxi, 399.



# INTRA ABDOMINAL PRESSURES CREATED BY VOLUNTARY MUSCULAR EFFORT

## III. RELATION TO BODY MEASUREMENTS, WITH A COMMENT ON ETIOLOGY OF GENITAL PROLAPSE

WILLIAM F MENGERT M.D. AND DOUGLAS P MURPHY M.D. F.A.C.S., PHILADELPHIA

From the Gynecologic Hospital Institute of Gynecologic Research, School of Medicine, University of Pennsylvania

IT has long been a matter of clinical observation that stout women are more prone to develop genital prolapse than thin women. Consequently the question arose whether stout women and more generally women whose bodily measurements are at the upper limits of normal might create unusually high pressures within the abdomen during the course of routine daily activity. It was further suggested that intermittently created high pressures might be a factor in the causation of prolapse of the uterus and vaginal walls. Therefore the present study of 60 normal women was undertaken in an effort to reach a greater understanding of intra abdominal pressure conditions resulting from voluntary muscular effort especially in relation to the part pressure may play in the causation of prolapse.

### MATERIALS AND METHODS

The subjects included 60 women of ages varying between 18 and 60. Fifty of them were inmates of the Philadelphia House of Correction and the remaining 10 were secured from other sources. All of them were healthy at the time of testing. As the nature of the experiment necessitated maximum voluntary muscular activity only women who were willing to be tested were used.

The method of testing was identical with the technique developed and used in collecting the data for the first two papers (1, 3) of this series. Briefly each subject strained maximally 20 times at intervals of not less than 1 minute upon an air inflated balloon within the vagina, and readings were made on a mercury manometer connected with the balloon. It has been demonstrated previously (3) that this method gives a satisfactory measure of pressure created within the abdomen by muscular effort.

In addition the age, abdominal girth, height and weight of each subject were recorded.

### RESULTS

All the data including results of 1200 tests upon the 60 women are given in Table I. Each pressure recorded in the table is therefore the average of 20 tests on a single woman.

In order to determine whether the pressures were related to any of the other measurements, they were plotted in 4 scatter diagrams, Figures A, B, C, D according to age, abdominal girth, height and weight respectively. It will be seen at a glance that these charts are true scatter diagrams in the sense that the individual points are so scattered that no relationships seem to exist.

In addition four different groupings of the data, each comparing the average pressure created by one-half the subjects against that created by the other half were made. For example, the average pressure created by the 30 youngest women was compared with the average pressure created by the 30 oldest. Completely rearranging the data, the average pressure created by the 30 women with the smallest abdominal girths was compared with that of the 30 women with the largest abdominal girths. A third and fourth rearrangement of the data were made so that the average pressure created by the 30 shortest versus that created by the 30 tallest women and the average pressure created by the 30 lightest versus that created by the 30 heaviest women could be compared. The results are given in Table II. The pressure difference did not exceed 1.0 centimeter of mercury in any of the 4 categories age, girth, height or weight. It will also be seen from Table II that each difference falls far below 3 times the standard error, the accepted statistical standard of a significant difference.

TABLE I.—SUMMARY OF DATA

Identification	Age years	Height cm.	Weight kg.	Girth at umbilicus cm.	Average pressure created cm. Hg.	Identification	Age years	Height cm.	Weight kg.	Girth at umbilicus cm.	Average pressure created cm. Hg.
1	15	154.4	37.8	64	11.9	31	25	151.5	40.3	63.0	9.8
2	19	140.0	45.8	63.0	12.6	32	29	155.3	61.3	70.0	10.6
3	19	137.5	33.8	60.5	12.6	33	30	165.1	83.7	104.0	17.5
4	19	152.5	60.9	66.0	12.4	34	30	155.0	55.3	74	11.4
5	19	155.0	83.6	71.0	12.7	35	31	160.0	48.6	68.0	10.1
6	19	156.0	71.4	73.7	12.7	36	3	158.6	50.9	66.1	14.0
7	19	161	64.8	75	12.3	37	37	151.8	33.6	71.5	13.4
8	20	163.0	64.0	73.0	12.8	38	23	167.0	55.0	70.0	12.0
9	21	157.5	37.5	66.0	12.5	39	33	153.4	48.6	67.0	23.0
10	21	155.0	86.6	69.5	14.6	40	24	160.0	64.8	65.0	11.8
11	21	155.0	48.6	64.0	14.4	41	26	157.5	57.5	70.0	10.6
12	21	162.5	0.7	100.0	14.0	42	28	160.0	70	83	19.6
13	21	160.0	51.6	65.5	15.5	43	28	155.0	44.6	65.5	8.6
14	22	157.5	54.6	68.0	0.5	44	28	166.0	65.6	76.5	13.0
15	22	149.8	45.8	61.0	12.1	45	28	160.0	40.5	73.0	11.8
16	22	162.5	55.3	74.0	7.0	46	28	150.0	20.0	121.0	13.7
17	2	157.5	51.6	69.0	7.7	47	30	155.0	61.8	75.0	12.3
18	22	153.8	43.8	58.0	10.0	48	40	157.5	60.6	87.5	9.8
19	23	160.0	58	67.0	12.0	49	40	160.0	33.8	70.0	12.5
20	23	155.0	52.7	68.5	17.2	50	40	156.8	76.8	84	8.5
21	24	160	48.4	6.0	11.1	51	42	159.8	50.6	78.0	12.1
22	24	156.2	63.2	73.0	0.6	52	42	145.0	62.2	97.0	9.6
23	24	165.1	8.3	83.0	23.2	53	43	165.1	81.6	95.0	13.7
24	25	148.0	48.8	71	13.5	54	43	162.5	77.7	97.0	18.8
25	26	165.1	59.6	72.0	5.0	55	45	160.0	47.4	68.0	12.5
26	26	155.0	86.8	93.0	18.8	56	46	167.7	89.1	102.0	12.8
27	27	162.5	55.4	71.0	8.0	57	48	166.3	68.7	82.0	12.8
28	27	17.7	73.3	8.0	12.1	58	49	163.0	95.4	122.0	1.2
29	27	172.7	65.0	70.0	12.0	59	54	156.2	65.0	101	7.0
30	27	144.6	50.0	65.3	15.3	60	60	163.1	65.4	93	8.6

Each pressure average is based upon 20 measurements.

TABLE II.—RELATION OF PRESSURE TO AGE, GIRTH, HEIGHT, AND WEIGHT

Grouping	Average age, girth, height, and weight of each half of each grouping		Average pressure of each half of each grouping (cm. Hg.)		Differ- ence between 1st and 2nd (cm. Hg.)	3 times the standard error of the dif- ference
	1st 30	2nd 30	1st 30	2nd 30		
Age	21.3 yrs.	35.0 yrs.	12.3	12.6	0.7	7.7
Girth	64.4 cm.	67.7 cm.	5	3.4	0.0	1.5
Height	155.9 cm.	163.7 cm.	12.8	3.1	0.3	7.7
Weight	5.0 kg.	73.3 kg.	12.5	12.5	1.0	7.4

## CONCLUSIONS

From a theoretical basis static pressure within the abdominal cavity depends upon the tonus of the surrounding musculature

The average pressure created by the 30 youngest women compared with the average pressure created by the 30 oldest women. Also the comparison of the average pressures created by the 30 women with the smallest abdominal girths versus that created by the 30 women with the largest abdominal girths. Also similar comparisons with respect to height and weight.

Note: (1) the actual pressure difference between any two groups in the same category is very small, never exceeding 1.0 centimeter of mercury; (2) each difference falls far below 3 times the standard error of the difference, thus indicating it is not significant.

(Keith) As a corollary pressures created by voluntary muscular effort must depend upon the development and efficiency of this musculature and only in a general way if at all upon body measurements.

Our findings bear out this theory. In a study of 60 normal women we were unable to demonstrate any relation between age, girth, height or weight and ability to create pressures within the abdomen. Consequently we feel that the obese woman is no more able to create unusually high intra-abdominal pressures than the thin woman with well developed abdominal diaphragmatic, and pelvic floor muscles.

This suggests that if obese women are prone to develop genital prolapse it is not because they create higher intra abdominal pressures than do other types.

#### REFERENCES

1. KEITH, A. Man's posture: its evolution and disorders; adaptations of abdomen and viscera to orthograde posture. Brit. M. J. 1923, I, 587-900. (Hastings Lectures)
2. MURPHY W F., and MURPHY D P. Intra-abdominal pressures created by voluntary muscular effort. II. Relation to posture in labor. Surg. Gynec. & Obst., 1933, 66, 745-751.
3. MURPHY D P. and MURPHY W F. Intra-abdominal pressures created by voluntary muscular effort. I. Technique of measurement by means of the vaginal balloon. Surg. Gynec. & Obst., 1933, 66, 437-403.

## A NEW TREATMENT OF OSTEOMYELITIS

## PRELIMINARY REPORT

M. A. STEWART Ph.D. HOUSTON, TEXAS  
The Rice Institute

THE rôle of osteomyelitis in the general practice of medicine, and particularly in orthopedics, is too prominent and too well known to warrant or make necessary its discussion here. However, in passing, it may be well to point out some of the mechanics of osteomyelitis. The classical description of inflammation denotes the characteristic presence of calor, dolor, rubor, and tumor but, as Hawk (1933) points out, inflammation in bone tissue is somewhat different from that in soft tissues. Here the tissue is rigid and swelling is consequently absent, though the other conditions are present. When the exudate resulting from inflammation and constituting a defensive barrier, expands in osseous tissue it is forced back into rigid channels. It becomes perfectly obvious therefore, that in an acute bone inflammation rapid destruction of osseous tissue follows. It has been stated that bacteria causing bone infections are invariably virulent. This statement must stand in view of the fact that even if the bacteria do become attenuated and the inflammatory process is stopped with the normal functions of the body remaining unassisted, a chronic bone abscess persists. This abscess discharges for long perhaps indefinite periods of time because of its presence in rigid tissue which will not expand and permit efforts sufficient for healing. Inflammation is the manifestation of the tissues of their attempt to destroy the bacteria, render the bacterial toxins inert, remove the necrotic debris, and repair the tissue damage. Any treatment that aids the body in this work by stimulating the exudate and neutralizing the bacteria and their toxins, is desirable. Unfortunately, however, many treatments for osteomyelitis while designed for these purposes actually thwart them.

Many therapeutic procedures have been advocated and several are still in more or less common use. Notable among those treatments employed at present are the establish-

ment of drainage gutters by surgical means, irrigation with Dakin's solution, Orr's method, maggot therapy, the use of bacteriophage, and packing with a paste made of glycerol and magnesium sulphate. Unfortunately, no single one of these treatments is effective in all cases and most of them offer little hope of successful results in any case.

One of the most recent of these treatments, and apparently the most successful is that of the late Dr. William Baer of Johns Hopkins in which sterile living maggots which feed exclusively upon necrotic tissue, are used. But even this treatment has some points in its disfavor and is contra indicated in some cases.

## NEW TREATMENT

Dr. Baer made the statement that probably some biochemical action of which he knew nothing was responsible for the apparent success of maggot therapy. Such a thought is very intriguing because, if a chemical substitute for maggots could be found, all of the disadvantages of Baer's method would thereby be entirely eliminated. With this idea in mind the writer began a series of experiments reported briefly herein, in an attempt to determine how maggots effect a cure in cases of osteomyelitis. The idea of making an extract by macerating sterile maggots in sterile normal saline with a mortar and pestle was discarded because it was felt, in the first place, that an extract of practically any invertebrate made in this way would probably show some bactericidal properties and, in the second place, it was recognized that if a bactericidal extract were secured in this manner, accurate chemical analysis and consequent identification of the active principle, or principles would be practically impossible. It is interesting to note here that Livingston and Prince (1932) subsequently and independently, utilized this discarded technique and did secure a compound possessing bac-

tencidal properties. Following the abandonment of the original idea it was decided to make extractions of living sterile maggots in a Soxhlet extractor with alcohol acetone and other chemicals being used as extracting agents. Alcohol and acetone extractions were made and no substances with appreciable bactericidal properties were secured. At this stage of the investigations it was accidentally discovered that the maggots (*Lucilia sericata* Meig) exude calcium carbonate through their body walls. It was found by means of the Roe and Kahn colorimetric method of calcium determination that one hundred maggots will excrete an average of 0.6 milligram of this substance each 24 hours. It was previously known that the larvae of a great number of flies contain within their bodies a large quantity of stored calcium carbonate but it is recorded nowhere that this is eliminated in any way other than with the puparium. This discovery was significant because here is calcium carbonate being eliminated constantly even in small quantities, into the wound and because as Heckhold (1929) has pointed out calcium ions stimulate phagocytosis.

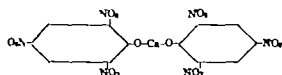
With this information at hand the next step in the problem was to find a way by which the leucocidin excreted by the bacteria might be controlled because unless it could be eliminated rapidly or rendered inert the phagocytes would be killed about as rapidly as they appeared at the focus of infection. It seems possible if not probable that the maggots absorb through the intestinal wall or the body wall or both this exotoxin given off by the bacteria and render it non toxic in their bodies (such a phenomenon is not unknown in the animal kingdom) or that they ingest it and render it non toxic in the alimentary canal through digestive processes. Coincidentally with this treatment of the leucocidin the exuded calcium carbonate increases phagocytosis. Such a hypothesis, however was of no assistance in furthering the investigation in search of chemical substitutes for living maggots. Therefore it became necessary to develop a theory relative to the chemical nature of leucocidin in order to devise a way of rendering it inert. Speculation on this aspect of the problem led to the belief

that the exotoxin might be protein in nature, i.e. a polypeptid or an amine and if so a dilute aqueous solution of picric acid would readily render it insoluble and thereby inert. Admittedly we are faced here with a hypothesis very difficult to prove as is readily seen when one considers the difficulties of collecting any quantity of pure bacterial exotoxin and of identifying polypeptids and amines chemically. However as we shall see later on in this paper such a hypothesis is strongly supported by clinical evidence.

On the basis of the data and hypothesis mentioned experimental treatments were started. Early experimentation showed the undesirability of using unmodified dilute aqueous picric acid solution (0.25 per cent) because of the relatively high surface tension which prevented the acid from gaining access to all of the crypts and crevices of the wound and thereby to all of the liberated leucocidin. This difficulty was easily met by adding enough glycerin to the solution to make an 8 per cent glycenn content which reduces the surface tension to an entirely negligible quantity. Early therapeutic experimentation upon laboratory animals guinea pigs, showed that when 0.25 per cent saturated aqueous solution of picric acid containing 8 per cent glycerin alone was used the progress was not especially marked although there was some slow improvement. When an autoclaved aqueous suspension of calcium carbonate, 20 grams calcium carbonate to 215 cubic centimeters distilled water was used alone considerable progress was noted but this progress showed a very strong tendency to be superficial indicating a possible unsatisfactory struggle between phagocytes and leucocidin. However when the picric acid solution and the calcium carbonate suspension were used together progress was very marked and rapid in its course.

After the preliminary experimental treatments had been concluded clinical work was started at the Jefferson Davis Hospital in Houston followed later by work at Methodist Hospital St. Joseph's Infirmary and Hermann Hospital. The technique employed in administering this treatment to humans is very simple there is nothing that cannot be

done by the average hospital nurse, after the surgery has been performed. This treatment, like both Orr's and Baer's is postoperative except in rare cases in which there is relatively free access to the focus of infection by means of spontaneous drainage sinuses. The necrotic bone is first removed surgically the excavation being made long and as narrow as possible so that the strength of the shaft may be retained and because the cavity will close much more quickly when the granulating sides are not widely separated. Following the operation the wound is packed for 24 hours with vaseline gauze in order to allow the trauma to subside somewhat. At the end of this period, the vaseline gauze packing is removed and the wound is thoroughly irrigated with the picric acid glycerin solution by means of a syringe. This solution with its reduced surface tension, quickly penetrates to every crypt in the wound and thereby gains access to the leucocidin and some of the bacteria as well. Usually no attempt is made to remove the picric acid solution from the wound and within a few seconds' time an aqueous suspension of calcium carbonate is sprayed into the wound by means of a nasal atomizer until a thin layer of precipitate is laid down over the osseous and soft tissues. A small quantity of the suspension will suffice for this purpose. The calcium carbonate combines with the picric acid solution to form calcium picrate



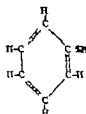
The action which takes place as a result of the introduction of these chemicals is very rapid and is that which is to be most desired when one contemplates the exact pathological conditions existing in osteomyelitis and the consequences of such conditions. The picric acid is given an opportunity to reach the greater quantity of the leucocidin and apparently acts upon it immediately. Then the calcium carbonate is added, forming calcium picrate and the calcium ions are rendered available to stimulate phagocytosis. Also as is well known dead protoplasm is acid and any wound in which acid debris is allowed

to remain suffers from a diminution of oxygen tension in the granulation tissue cells which in turn stimulates the autolytic enzymes contained within these cells to dissolve the surrounding protoplasm. Furthermore, acid causes a swelling of the tissue cells which pushes deeper into the bone canals the barriers that have been erected, thereby bringing about the deleterious consequences described at the beginning of this paper. The calcium carbonate controls this dangerous acidity by maintaining a neutral or even alkaline condition the degree of which depends upon the condition of the wound and the amount of calcium carbonate present. It has been further observed in every case treated that the rate of drainage increases very rapidly thereby inhibiting the dangerous pushing back into the rigid bone the defensive barrier as well as removing debris. Moreover calcium picrate has very definite analgesic properties with consequent relief to the patient. After the calcium carbonate suspension is applied to the wound it is packed with dry gauze in order to prevent closure. When the foci of infection are very deep and it is impossible to reach them as described the picric acid solution and the calcium carbonate suspension are applied through Dakin tubes with the ends cut off or through male catheters which are placed in the wound and packed in place with vaseline gauze or they may be in some cases pushed down through the sinus tracts as needed.

Ordinarily these treatments are given three times a week, but in very severe acute cases they are usually given daily for the first week or two and thereafter three times weekly. The patient usually reports a 'more comfortable feeling' after the very first treatment and in every instance improvement has been clearly observed in not more than a week after the first treatment. After the first week of treatment the drainage usually becomes less copious the macroscopic and microscopic appearance of the exudate indicates improvement bone destruction is arrested and the soft tissue shows extremely healthy granulations. In passing, it might be pointed out that one of the most significant points in the contention that the calcium carbonate is the true active principle of the maggots is the type

of granulation tissue formed as a result of its introduction into the wound. The granulation tissue resulting from maggot introduction is of a smooth type and possesses a peculiar glistening sheen—such tissue appears to be specifically characteristic of maggot therapy. A macroscopically identical type of granulation tissue is immediately produced when calcium carbonate is applied to the wounds.

Frequently in cases of osteomyelitis of the tibia a sloughing of the soft tissue occurs after the wound has been granulating for some time. In an attempt to check this sloughing an aqueous suspension of thiophenol



was applied to the wound with a cotton applicator. This suspension is made of 1 part thiophenol and 10 parts distilled water. The water is boiled before the thiophenol is added in order to eliminate the free oxygen. It is believed that the thiophenol aids the normal metabolism of the tissue by preventing sulphydryl groups which may function in the manner of glutathione. Superimposed upon this is undoubtedly the normal bactericidal effect. The results of this procedure are very striking one and at the most three applications suffice to check the sloughing and granulation continues as before.

Table I is a summary of all of the cases treated by this new method. Before turning to this table a brief explanation of it is necessary. It was not always possible to determine the exact onset of the infection before admission because of the frequently faulty memory of the patients. The admission date as recorded, refers strictly to admission to the osteomyelitis clinic or to treatment while the patient was still hospitalized. In regard to previous treatment, it should be pointed out that all cases unless otherwise stated, were making no improvement or were getting worse under the previous treatment at the time of admission to the clinic to receive the pacific

and calcium carbonate treatment. The lists of operations are admittedly incomplete in some cases because of poor memory on the part of patients and inaccessible records. It will be noted in this column of the table that operations performed before the institution of the new treatment, as well as those performed afterward are listed. The dates of disappearance of infection have been calculated most conservatively. The date recorded is that of 1 month after it was first believed that an infection no longer existed. During this month the patient was seen three times weekly and carefully observed for an infective process. Negative findings for this entire period indicated the determination of the date as stated above. In some cases it will be noted that the condition of the wound rather than a disappearance of the infection is reported over a date. These patients left the clinic and failed to reappear before the course of treatment was completed. The dates in these latter cases refer to the last time the patient was seen.

As indicated in Table I certain cases require more complete explanation.

**CASE 1.** This case was apparently of long duration but no information of any value whatsoever could be obtained from the patient or his parents. On January 3, 1933 large swellings appeared on the lateral and medial aspects of the left upper arm. X-ray examination showed a well advanced and very active osteomyelitis of the left humerus. These foci of infection were apparently of long duration. On January 17, 1933 a large inflamed swelling appeared on the right upper arm and X-ray examination showed an active focus of infection of the right humerus this focus also was well advanced. Then it became obvious that the infection had become established throughout the body. Upon recommendation of radical surgical procedure, the patient left the clinic and failed to return. It is felt that, since the pathological condition of the patient was so far advanced and he was in such a weakened state, little or nothing could be done to alleviate the condition.

**CASE 2.** This patient suffered a supracondylar compound fracture on June 14, 1932. It is believed that the onset of the infection dated nearly a month before the patient was referred to the osteomyelitis course of treatment.

**CASE 3.** This case is of interest because of the probable hectic origin. In addition to the regular treatment a course of neosalvarsan was given.

**CASE 10.** This patient was treated from July 27, 1932 until October 10, 1933 with the picric acid glycerin solution only and progress was so slow

TABLE I—SUMMARY OF CASE REPORTS

Case No	Diagnosis	Age	Onset before admission	Admission	Previous treatment	Operations	Disappearance of infection	Duration weeks
1†	Right femur	13	Indeterminate	10-30-1931	None	10- 5-1932	Multiple infection developed. Femur greatly improved 1-10-1933	13
†	Right humerus	2	Occurred while in hospital	7-16-1931		Open reduction of fracture 6-6-1932	1- 5 1933	16
3	Right tibia	47	0-10-1931	7-9- 32	Orr's	2-25-1932	0-30- 33	10 1/2
4	Right femur	26	1-17-1931	6-13- 32	Orr's	3-7-1932	Greatly improved 0- 7-1933	15
5	Third and fourth metatarsals	43	2-30-1931	12-30- 32	None	12-24- 32	4- 1 1933	3
6	Right radius and ulna	20	0-15- 32	6-21- 32	None	6-21-1932	8-7-1933	6
7	Right tibia and fibula	24	3-10- 32	6-25-1932	Orr		Very greatly improved 8- 1933	44
8†	Left tibia, foetal osteoparionitis	19	10- 1931	10-18- 32	None		Very much improved 1-26- 33	2 1/2
9	Left tibia and fibula	43	12-23- 32	6- 1 1932	Orr's	1-23-1932	3-19-1933	20 1/2
10†	Left femur	8	3-1932	0-10-1932	Orr's Phlegic acid sol	0-27-1932	2-1-1933	16
11†	Right second metatarsal, cuneiform, scaphoid, and cuboid	8	10-10-1931	7-16- 32	Orr's	10-30-1931 8- 8-1932	10-7-1932	11
11†	Right tibia and fibula	6	2-15-1932	6-28-1932	Orr's	6-28-1932	7-21-1932	3
12	Right tibia	8	10- 4 1930	7- 8-1932	Orr's	3-22-1932	10- 1-1933	11
12	Left tibia, astragali, and calcaneus	13	8-31-1931	10-20- 32	Orr's	0- 7-1932 10-20- 32	12-16-1932	7
13	Brodie's abscess, left tibia	20	4- 3 1932	0- 1 1932	Antiseptic	4- 4 1932	Very much improved 10-29-1932	8
16	Left great toe	47	1- 9-1931	2-30- 32	None	12-16-1932	8- 6-1933	7
17	Right first metatarsal	18	7- 5 1932	8- 7- 32	None	8- 6- 32	Practically disappeared 0-1-1933	2 1/2
18	Right femur	27	5- 7-7	8-15- 32	Intermittent immobilization	7-30-1932 1- 7 1933	2-15- 32	29
19	Left radius and ulna	24	4- 0-1932	7- 0- 32	Orr's	3- 7 1932	11-31-1932	5
20	Right foot	1	6-3- 32	6- 1932		6-30-1932	8- 0-1932	7
21†	Right tibia	27	7-3-1931	7-23-1931	Orr's maggots	10- 2- 31 1-23-1932 6- 1- 32	4- 1- 32	26
22	Right femur and left tibia	60	10- 4	6-25-1932	Orr's	1932 3-30-1932 0-25- 32 10- 8-1932 3-23-1933	Very greatly improved 5-15-1933	26
23	Left fibula	45	0- 2-3	3-28- 32	Orr's ultra violet ray	0- 0-32 4-10-30 12-1932 4- 1 1933	2-15-1933	7
24	Second phalanx second finger right	26	11-25-1931	12- 1- 32	None		11-30-1932	4
25	Left femur	23	19- 1	3-16- 32	Orr's	1-23-1932	Only slight infection 8- 3- 32	8 1/2
26	Right femur	33	11- 1 1931	11-30-1932	None	11-26- 32	Greatly improved 1- 7 1933	2 1/2
27†	Right tibia	20	3-10-1932	7-10- 32	Orr's	3-18-1932	No improvement 10-20-1932	14 1/2
28	First metatarsal, left	24	4-10-1931	7-2-1932	Orr's	6- 8-1932	8-30-1932	4



TABLE I—SUMMARY OF CASE REPORTS—Continued

Case No.	Diagnosis	Age	Course before admission	Admission	Previous treatment	Operations	Disappearance of infection	Cure in weeks
29	Right tibia	34	7-1932	7-15-32	None	8-2-32	8-32	27
30	Left tibia	17	9-17-32	2-1933	Orr's	8-1932	Greatly improved 2-1933	5
31	Right tibia and fibula		8-9-30	6-5-31	Orr	4-9-32 3-6-32 2-7-32 9-18-32	2-1933	21 1/2
32	Great toe right foot	5	6-32	7-0-32	None	7-16-32	9-32	6
33	Left tibia and fibula		5-9	6-8-32	Orr's	8-20-32 9-2-32 9-1932	11-1932	10
34	Right tibia and fibula	30	9-32	9-32	None		2-2-33	1 1/2
35	Left tibia	5	5-32	20-1932	Orr	2-9-32	Greatly improved 3-16-32	3
36	Left tibia and fibula		10-1930	2-20-32	Orr	2-10-32	2-13-32	
37	Left calcaneus	7	1-32	6-2-	Orr	4-8-32 8-20-32	2-5-32	16
38	Right tibia and fibula		9-6-30	6-32	Orr	9-2-32 2-12-32	Very greatly improved 5-32	27 1/2
39	Right tibia and fibula		2-8-32	2-1932	None	7-32 8-32 8-1932	Very greatly improved 2-18-32	12
40	Left tibia	22	5-32	8-9-32	None		2-1932	1
41	Left femur		7-32	10-1-32	Immature lesion	10-2-32 10-27-32	5-32	16 1/2

These are all cases of osteomyelitis unless otherwise stated.  
 (Diagnosis) further in text of paper.  
 (Treatment) through modified Dicks' tubes or male catheters.

that only a very slight degree of improvement could be noticed at the end of the period. After the addition of the calcium carbonate suspension to the treatment, however, the rate of improvement was very markedly increased. These results substantiated the findings in the comparative treatments of guinea pigs described earlier in the paper.

**CASE 11.** This patient was improving under Orr's method of treatment but after the new treatment was begun the rate of improvement was very markedly increased.

**CASE 12.** This patient was progressing well under Orr's treatment but the increase in the rate of improvement after the new treatment was begun vividly impressed all of the observers who had been watching the case for some time.

**CASE 21.** As indicated in Table I, maggot therapy was tried in this case before administering the piecic acid calcium carbonate. Five implantations of maggots were made into the wound but in each instance the maggots either left the wound or drowned because of very copious drainage. As will be described such a difficulty is not infrequently encountered when maggots are employed in osteomyelitis wounds.

**CASE 27.** No improvement was noticed in this case after 14 1/2 weeks of treatment. This failure can be easily explained by the fact that soft tissue had

grown over the infected tibia and the patient would not permit an incision and curettage of the infected area thus allowing the chemicals to reach the focus of infection. This case constitutes the single failure in the entire series.

Three cases not reported in Table I because at no time was the complete treatment administered should be briefly discussed at this time.

**CASE 42.** Male colored aged 37 years, had osteomyelitis of the right tibia and fibula. Diagnosis was made September 15 1931. He was treated by Orr's method from September 15 1931 until June 28 1932 with but little improvement. He was treated with calcium carbonate suspension from June 28 1932 until September 20 1932 with but very slight improvement. The wound would appear to be healing and would then break down again.

**CASE 43.** Female, white, aged 46 years, had an osteomyelitis of the left tibia. Diagnosis was made February 10 1932. She was treated from February 10 1932 until June 4 1932 by Orr's method, with no noticeable improvement. She was treated with calcium carbonate suspension alone from June 4 1932 until December 20 1932. Some improvement in original focus of infection was noted but the

spread of the infection throughout the length of the shaft was not checked

CASE 44. Male colored aged 21 years, had a staphylococcus pyogenes aureus infection in the soft tissue on the dorsum of the left foot. Diagnosis was made July 14 1932. He was treated with picric acid glycerin solution alone from July 14 1932 until December 20 1932. It is readily seen that the rate of progress was very slow. It is quite certain that such would not have been the case had the calcium carbonate suspension been administered in addition to the picric acid solution in view of the experience in those cases in which the complete treatment was given.

These 3 cases serve to substantiate the findings of the comparative treatments upon the guinea pigs. Apparently the picric acid while caring for the greater part of the leucocidin does not kill all of the bacteria present, and the calcium carbonate while increasing phagocytosis cannot do this at a sufficient rate to overcome the effects of the uncontrolled leucocidin, whereas in the complete treatment the picric acid controls the leucocidin thus enabling the stimulated phagocytes to care for the bacteria.

From this preliminary report, and any report of an investigation of the treatment of an infection of this sort which has not been conducted over a period of several years must necessarily be preliminary, certain conclusions can be drawn. If we compare Table I with the table given by Kulowski (1931) in his paper reporting 155 cases of osteomyelitis treated by Orr's method we are immediately impressed by the shorter duration of treatment required by the method reported in this paper. There is, furthermore at the most not more than 50 per cent as much scar tissue formed when this treatment is used as when Orr's is employed which of course means much greater subsequent function of the afflicted member and a greatly decreased possibility of subsequent breaking down of the poorly nourished fibroid tissue. Also the picric acid calcium carbonate treatment requires a very much decreased degree of immobilization with consequently increased circulation and greater comfort for the patient. The postoperative technique employed in the new treatment is much simpler than in Orr's treatment and the expense to the patient is decreased. Finally, as will be discussed in a later paragraph Orr's

treatment is far from satisfactory in very many respects and many orthopedists are beginning to see fallacies in the theory advanced to support it.

If we attempt to compare the treatment described in this paper with Baer's method we find several factors which lead us to believe that the new treatment is the better of the two. This statement is not based alone upon rather extensive personal experience with the employment of maggots but upon criteria which Baer (1931) himself used in reporting his treatment of 89 cases. From Baer's report and tables we see at once that the picric acid calcium carbonate treatment effects healing even more quickly than do maggots. Furthermore there is no danger of introduced contamination as there is in maggot therapy. The patient suffers no discomfiture as he does from the scavenging activities of the maggots but benefits instead from the analgesic properties of the calcium picrate. The expense is only a small fraction of that of maggots and the patient is filled with no feeling of disgust. The new treatment moreover can be used in cases in which there is excessive drainage which is actually beneficial, whereas in maggot therapy such drainage is definitely inhibitory. The patient is invalided to no greater degree than by Baer's method and while the dressings are a trifle more frequent the total labor involved is very much less. While it has been demonstrated by clinical experience that this type of treatment is not to be preferred over maggots in wounds in which a great deal of necrotic tissue is present and cannot be removed surgically, it has also been demonstrated that in all other types of osteomyelitis wounds the picric acid calcium carbonate treatment is to be preferred. In deep infections such as hip infections maggots cannot be successfully used, but the new treatment can be employed by means of modified Dakin tubes or male catheters very easily and effectively. Furthermore whereas maggots are indicated when there is an abundance of necrotic tissue after a certain stage of progress has been attained and most if not all of the necrotic debris has been removed they hinder rather than aid the final healing process and at this stage the chemicals men

TABLE I—SUMMARY OF CASE REPORTS—Continued

Case No.	Diagnosis	Age	Onset before admission	Admission	Previous Treatment	Operation	Dissemination of Infection	Duration (months)
26	Right tibia	18	-1932	7-15-33	None	10-8-1932	2-1932	27
27	Left tibia	0-1		10	Orr	6-8-32	Grossly improved 2-3-33	1
28	Right tibia and fibula	24		8-3-32	Orr	6-10-31 3-6-32 2-12-1932 9-17-1932	2-1932	21 1/2
29	Unlabeled right foot	3		1-10-3	None	7-6-1932	6-1932	4
30	Left tibia and fibula	0		6-8-32	Orr	6-20-32 6-3-33 22-10-32	-12-32	20
31	Right tibia and fibula	29		9-12	None		2-12-1933	21 1/2
32	Left tibia			29	Orr	-12-33	Grossly improved 2-12-33	2
33	Left tibia and fibula	9-10		2-20-32	Orr	0-9-32	2-3-1933	1
34	Left calcaneus	0		15-32	Orr	4-8-32 2-20-1932	2-3-1932	20
35	Right tibia and fibula	10		0	Orr	9-8-30 12-32	Very grossly improved 2-1932	21 1/2
36	Right tibia and fibula	2-9			None	7-1932 4-10-32 6-5-32	Very grossly improved 2-12-1932	17
37	Left tibia	1-3-32		8-9	None		-6-1932	12
38	Left femur	7-10		10-8	Prothrombin	10-12-1932 6-17-33	5-32	21 1/2

There are 11 cases of osteomyelitis under reference stated.

† Discussed further on top of paper.

Bruch = through modified Dugas' box, male catheter.

that only a very slight degree of improvement could be noticed at the end of the period. After the addition of the calcium carbonate suspension to the treatment, however, the rate of improvement was very markedly increased. These results substantiated the findings in the comparative treatments of gonorrhea pigo described earlier in the paper.

CASE 11. This patient was improving under Orr's method of treatment but after the new treatment was begun the rate of improvement was very markedly increased.

CASE 12. This patient was progressing well under Orr's treatment but the increase in the rate of improvement after the new treatment was begun vividly impressed all of the observers who had been watching the case for some time.

CASE 21. As indicated in Table I, maggot therapy was tried in this case before administering the peptic acid calcium carbonate. Five implantations of maggots were made into the wound but in each instance the maggots either left the wound or drowned because of very copious drainage. As will be described, such a difficulty is not infrequently encountered when maggots are employed in osteomyelitis wounds.

CASE 27. No improvement was noticed in this case after 14 1/2 weeks of treatment. This failure can be easily explained by the fact that soft tissue had

grown over the infected tibia and the patient would not permit an incision and curettement of the infected area thus allowing the chemicals to reach the focus of infection. This case constitutes the single failure in the entire series.

Three cases not reported in Table I because at no time was the complete treatment administered should be briefly discussed at this time.

CASE 42. Male colored aged 31 years, had osteomyelitis of the right tibia and fibula. Diagnosis was made September 15, 1931. He was treated by Orr's method from September 15, 1931 until June 18, 1932 with but little improvement. He was treated with calcium carbonate suspension from June 18, 1932 until September 20, 1932 with but very slight improvement. The wound would appear to be healing and would then break down again.

CASE 43. Female white, aged 46 years, had an osteomyelitis of the left tibia. Diagnosis was made February 10, 1932. She was treated from February 10, 1932 until June 4, 1932 by Orr's method, with no noticeable improvement. She was treated with calcium carbonate suspension alone from June 4, 1932 until December 20, 1932. Some improvement in original focus of infection was noted but the

and every observer must admit that the results have been far from satisfactory. The duration of treatment is usually long and the incidence of recurrence is entirely too high. There is a great deal of scar tissue formed during this type of treatment. Such an amount of scar tissue as is frequently, if not usually, formed as a result of this therapy, of course, spells a high degree of loss of function and too great a possibility of recurrence due to the breaking down of this poorly nourished fibroid tissue. A point of doubt in the minds of many is the theory upon which Orr's method is largely based, i.e., the action of a bacteriophage upon the pathogenic organisms. This doubt is very well founded as will be shown in a later paragraph where the treatment of osteomyelitis with phage is discussed. It may be pointed out here, however, that phage respire during its lysis of bacteria, such lysis occurs much more slowly in test tubes in which the oxygen tension is low than in those in which it is high, and obviously in a wound tightly packed with vaseline little respiration can occur. Furthermore while phage is not infrequently found in a wound it is usually not lytic to the wound bacteria since purulent material, exudate, blood, and diluted serum, all of which are retained to a very high extent in the wound under Orr's treatment, are inhibitory to the destructive action of phage, even in dilutions of 1:1000 as shown by Applebaum and MacNeal (1931). The advocates of Orr's method admit the prime importance of adequate drainage but as Hawk (1933) writes "But for adequate drainage to be secured in a rigid bone plugged with vaseline, a substance non miscible with water, and the part then enclosed in a plaster cast for an indefinite period, is more than the writer's imagination can encompass!" Orr (1927) strongly emphasized immobilization and the proponents of his therapy religiously follow this practice. Hawk (1933) again writes "We have emphasized that bone tissue is rigid to the nth degree, the only alteration that an enclosing plaster case can accomplish is to render the circulation more sluggish, and thus to interfere with healing. We advise getting the patient on his feet as soon as he has recovered from the mechanical work in the

operating room, provided enough bone has been left to support the limb. Bone is viable tissue, and living tissue increases its vitality with use. Not all of the bone is diseased, and the resistance of the viable part to the infection will be raised by use. Using a bone increases the blood flow, mobilizes calcium and stimulates the part to meet the demands placed upon it. The X ray shows absorption of calcium after one week in a limb that is immobilized for any cause, and this proves the delicate balance, to which bone is sensitive, between use and non use. It has been found by animal experimentation that ligating return veins in cases of arterial damage lessens the frequency of gangrene in the limb. Intra capillary tension is necessary for proper nutrition and the use of a limb in a dependent position increases both the blood pressure and the hydrostatic capillary pressure. When one views a patient lying in bed week after week, with the involved part enclosed in a cast and absorbing putrefactive products from the wound, with a sluggish circulation from no exercise, one is not surprised to see him sallow and toxic in appearance, and what little appetite he may have diminished by a foul stench! The author has seen this picture only too often the wonder is that the patient gets well at all.' It is felt that one should strongly hesitate before recommending such a treatment as described by Orr for osteomyelitis and this feeling is well substantiated by the facts heretofore presented.

Albee (1933) has recently published a paper on the treatment of osteomyelitis by bacteriophage in which he recommends the filling of the osteomyelitis wound with a paraffin vaseline plug and then introducing the bacteriophage into the wound, through catheters fixed in the plug, over a period of 6 months, at the end of which time recovery is claimed. In the preceding paragraph certain facts were pointed out as being inhibitory to phage activity and among the chief of these is the plugging up of the wound. Also, of course, such plugging inhibits drainage. Anyone familiar with bacteriophage and bacteriophage finds serious doubt arising in his mind over such a suggestion as this of Albee. The hopes of such a method of treatment being successful

can only be very slight in view of the following known facts, in addition to those previously presented of the phenomenon in question. In the first place, lysis of bacteria is a secondary phenomenon which may or may not follow the accumulation of phage depending on the conditions of the environment. These conditions of environment are principally the presence of old bacteria, colloids of tissues and colloids of body fluid. It is a well known fact that bacteriophage is adsorbed on such bodies and thereby inactivated. In the second place phage can be present for months without manifesting itself or becoming active because the bacteria are, for some as yet unknown reason resistant to it during this period of time. In the third place phage introduced into the body is usually entirely eliminated in from 24 to 48 hours. This elimination of bacteriophage cannot be counteracted by increasing the therapeutic doses because of the toxicity of phages. In the fourth place, repeated administration of moderate amounts of phage over a long period of time as Albee advises, is inadvisable because of the development of anti phage which abolishes all phage action. It may be pointed out here also that under conditions existing *in vivo* the susceptible bacteria as distinct from the resistant forms are not subject to lysis as freely as they are *in vitro*. We may conclude from our present knowledge of phage that the hope of utilizing bacteriophage as an agent for prevention and therapy of infection lies in finding the means of removing the obstacles to its activity in its natural environment and allowing it to act as freely as it does in test tubes. As yet we have no idea how this may be done. These arguments are not only in disfavor of Albee's method but of course of the method of Orr as well.

Hawk (1933) has proposed the packing of osteomyelitis wounds with gauze well impregnated with a paste made of one part glycerol and two parts of magnesium sulphate. His treatment is based upon the principles of increasing the exudation from the wound by the high exosmotic action of the magnesium sulphate and of using a solute, magnesium sulphate having a high valence and active ionization for the precipitation of colloids and

destruction of bacteria. It should be pointed out here that magnesium sulphate acts as a narcotic upon tissue cells and thereby retards phagocytosis while calcium ions stimulate the phagocytes. Also the very osmotic pressure of which Hawk writes not only increases the rate of drainage but very seriously dehydrates phagocytes and granulation tissue, thus bringing about a very abnormal condition in the healing tissue as well as killing the phagocytes. This action is continuous inasmuch as the wound is packed with the chemical. From Hawk's paper one may infer a belief on his part that bacteria are definitely eliminated from the wound by the increased amount of exudate. This is not necessarily so inasmuch as they may be deposited anywhere and since magnesium sulphate is not an effective bactericide continue to thrive. Whereas in the picric acid calcium carbonate treatment while some of the phagocytes may be killed off as many of the bacteria are, by the picric acid solution they are nevertheless immediately stimulated again upon the addition of the calcium carbonate to the wound. Hawk emphasizes the serious effects of the acid nature of the wound and yet this acidity is not diminished in the slightest and is probably slightly increased by the magnesium sulphate since this substance is slightly acid. In the case of the addition of calcium carbonate the acid is controlled and a neutral or slightly alkaline condition is maintained in the wound. Finally there is no advantage to be gained by the partial absorption of magnesium through the wound. It appears to be highly probable that magnesium could be found in the urine of the patients who were being treated by this method.

The writer wishes at this time to express his deep appreciation to those men without whose generous cooperation the investigation which is reported in this contribution could not have been accomplished. Dr. G. Holmes Richter of the Rice Institute has constantly acted in the capacity of a chemical adviser and has contributed many very valuable suggestions in the furtherance of the work. Drs. F. C. Bishopp and G. F. White of the U. S. Bureau of Entomology kindly supplied the maggots with which the work was started. Dr. James R. Best first made it possible for clinical investigations to be carried on at the Jefferson Davis Hospital and has given freely of his time. Dr. A. N. Boyd has been of invaluable assistance in directing the clinic and in constantly helping with the work at Jefferson Davis Hospital during the entire course of the

Investigation, in aiding in the analysis of case histories, in offering a great many valuable suggestions and in constantly encouraging and promoting the work in every possible way. Dr B. T. Van Zant has constantly and cheerfully assisted in the interpretations of X-ray plates. Dr J. M. Mitchner gave his complete co-operation during his period of service as chief of the orthopedic section at the Jefferson Davis Hospital and also at the same hospital Drs. H. J. Ehlers and L. Ewing Bush contributed valuable surgical and clinical assistance. Finally but by no means least, an expression of deep appreciation is due Dr Joe B. Foster for rendering available clinical facilities at St. Joseph's Infirmary and at Methodist and Hermann Hospitals, for arranging for opportunities to use Dakin tubes in introducing the chemicals into deep infections, for countless valuable suggestions, for cheerfully and generously giving his time in assisting in many of the details of the work, and for his constant encouragement.

## BIBLIOGRAPHY

- ALBRE, FRED H. Treatment of osteomyelitis by bacteriophage. *J. Bone & Joint Surg.* 1935 xv 58
- APPELBAUM, M. and MACNEAL, W. J. Influence of pus and blood on action of bacteriophage. *J. Infect. Dis.*, 1931 xlix, 225
- BAKER, WILLIAM S. The treatment of chronic osteomyelitis with the maggot (larva of the blow fly). *J. Bone & Joint Surg.* 1931, xlii, 438.
- BECKHOLD, H. Die Kolloide in Biologie und Medizin. 5 Umgearbeitete Auflage. Dresden and Leipzig Theodor Steinkopff 1929
- HAWK, CHARLES LYLE. The treatment of osteomyelitis. *J. Bone & Joint Surg.* 1933 xv 401
- KULORSKI JACOB. The Ort treatment of osteomyelitis and allied suppurative processes. A statistical analysis and discussion of 155 cases. *J. Bone & Joint Surg.* 1931 xlii 538.
- LIVINGSTON S. K. and PRINCE, L. H. Treatment of chronic osteomyelitis, with special reference to use of maggot active principle. *J. Am. M. Ass.* 1933 xcviij 1143.
- ORR, H. W. The treatment of osteomyelitis and other infected wounds by drainage and rest. *Surg. Gynec. & Obst.* 1927 xlv 446

can only be very slight in view of the following known facts in addition to those previously presented, of the phenomenon in question. In the first place, lysis of bacteria is a secondary phenomenon which may or may not follow the accumulation of phage depending on the conditions of the environment. These conditions of environment are principally the presence of old bacteria, colloids of tissues and colloids of body fluid. It is a well known fact that bacteriophage is adsorbed on such bodies and thereby inactivated. In the second place phage can be present for months without manifesting itself or becoming active because the bacteria are for some as yet unknown reason resistant to it during this period of time. In the third place phage introduced into the body is usually entirely eliminated in from 24 to 48 hours. This elimination of bacteriophage cannot be counteracted by increasing the therapeutic doses because of the toxicity of phages. In the fourth place repeated administration of moderate amounts of phage over a long period of time, as Albee advises, is inadvisable because of the development of anti phage which abolishes all phage action. It may be pointed out here also that under conditions existing *in vivo* the susceptible bacteria as distinct from the resistant forms are not subject to lysis as freely as they are *in vitro*. We may conclude from our present knowledge of phage that the hope of utilizing bacteriophage as an agent for prevention and therapy of infection lies in finding the means of removing the obstacles to its activity in its natural environment and allowing it to act as freely as it does in test tubes. As yet we have no idea how this may be done. These arguments are not only in disfavor of Albee's method but of course of the method of Orr as well.

Hawk (1933) has proposed the packing of osteomyelitis wounds with gauze well impregnated with a paste made of one part glycerol and two parts of magnesium sulphate. His treatment is based upon the principles of increasing the exudation from the wound by the high exosmotic action of the magnesium sulphate and of using a solute, magnesium sulphate having a high valence and active ionization for the precipitation of colloids and

destruction of bacteria. It should be pointed out here that magnesium sulphate acts as a narcotic upon tissue cells and thereby retards phagocytosis while calcium ions stimulate the phagocytes. Also the very osmotic pressure of which Hawk writes not only increases the rate of drainage but very seriously dehydrates phagocytes and granulation tissue thus bringing about a very abnormal condition in the healing tissue as well as killing the phagocytes. This action is continuous inasmuch as the wound is packed with the chemical. From Hawk's paper one may infer a belief on his part that bacteria are definitely eliminated from the wound by the increased amount of exudate. This is not necessarily so inasmuch as they may be deposited anywhere and since magnesium sulphate is not an effective bactericide, continue to thrive. Whereas in the picric acid calcium carbonate treatment while some of the phagocytes may be killed off as many of the bacteria are by the picric acid solution they are nevertheless immediately stimulated again upon the addition of the calcium carbonate to the wound. Hawk emphasizes the serious effects of the acid nature of the wound and yet this acidity is not diminished in the slightest and is probably slightly increased by the magnesium sulphate since this substance is slightly acid. In the case of the addition of calcium carbonate the acid is controlled and a neutral or slightly alkaline condition is maintained in the wound. Finally there is no advantage to be gained by the partial absorption of magnesium through the wound. It appears to be highly probable that magnesium could be found in the urine of the patients who were being treated by this method.

The writer wishes at this time to express his deep appreciation to those men without whose generous co-operation the investigation which is reported in this contribution could not have been accomplished. Dr. G. Holmes Richter of the Rice Institute has constantly served in the capacity of a chemical adviser and has contributed many very valuable suggestions in the furtherance of the work. Drs. F. C. Blahopp and G. F. White of the U.S. Bureau of Entomology kindly supplied the maggots with which the work was started. Dr. James R. Boet first made it possible for clinical investigations to be carried on at the Jefferson Davis Hospital and has given freely of his time. Dr. A. N. Boyd has been of invaluable assistance in directing the clinic and in constantly helping with the work at Jefferson Davis Hospital during the entire course of the



Fig. 1 Synovial membrane from Case 1 showing villus formation, increased vascularity and nodules of small round cells.

of motion persisted. In May 1932 a plaster cast was applied for 3 weeks and he was then given a brace and in October 1932 the knee was manipulated but the pain persisted and the knee became swollen after walking 6 or 8 blocks.

Physical examination revealed the right knee moderately swollen and the normal joint contour obliterated. There was some excess fluid in the joint and there was definite thickening of the periarticular tissues and the joint was quite tender especially over the middle third of the old operative scar mesial to the patella and over the anterior end of the external semilunar cartilage. Flexion was limited to 70 degrees and motion of the joint elicited marked rather coarse crepitus. There was considerable pain at the limits of flexion and extension when these motions were slightly forced. The lateral and crucial ligaments were intact.

Diagnosis was severe traumatic arthritis with probable old injury to the external semilunar cartilage. I advised synovectomy and removal of the external semilunar cartilage.

On April 4 1933 the right knee was opened through a vertical incision lateral to the patella. When the joint was opened about 20 cubic centimeters of rather dark straw colored fluid escaped. This fluid contained a few flakes of fibrin. The synovial membrane was markedly thickened and more vascular than normal and the fat pad was larger than normal. The external semilunar cartilage appeared to be normal. The margins of the articular cartilage were slightly invaded by the hyperplastic synovial tissue. On the external condyle of the femur there was an area about 2.5 centimeters in diameter in which the articular cartilage was softened and fibrillated. The cartilage over this area was split by numerous clefts and for the most part appeared to be dead and degenerating but a large

number of small slender villi arose from this area and projected into the joint cavity. The longest of these was over 2 centimeters long and their presence on the surface of the condyle gave this area a shaggy appearance. These villi appeared to be composed of living cartilage or dense connective tissue. The cartilage covering the articular surface of the patella was also softened and fibrillated and appeared to be degenerating. The area of degenerating cartilage was removed from the lateral condyle of the femur and practically all of the cartilage on the articular surface of the patella was removed. The external semilunar cartilage fat pad and synovial membrane were removed from the lateral portion of the joint and through a vertical incision mesial to the patella the synovectomy of the anterior portion of the joint was completed.

The convalescence was uneventful and the patient states that the joint is much more comfortable than it has been at any time since the injury and he is now walking without support and with no pain but flexion is limited to 110 degrees.

Microscopic examination of the articular cartilage from Case 1 showed necrosis of the surface of the cartilage with some fibrillation and death of the cells in the tissue adjacent to the clefts in the cartilage. The synovial surface presented many small folds and villi and the cells were moderately increased in size and number. The subsynovial tissue was more vascular than normal and was moderately infiltrated with small and medium sized round cells and the sections examined contained several small compact nodules of small round cells.





Fig. 2. Synovial membrane from Case 2 showing villus formation, synovial hyperplasia, and infiltration of the subsynovial tissues. Photomicrograph (up on the right shows fibrin in the joint cavity and adherent to the surface.

The articular cartilage from Case 2 was also necrotic and degenerating and its surface was broken by numerous clefts some of which extended down to the zone of provisional calcification but it contained many areas in which the cartilage cells were increased in size and number and had formed small cell nests. The villi which sprang from the articular surface were composed of an avascular tissue which resembled both hyaline cartilage and connective tissue. The stroma was for the most part hyaline but the cells resembled small connective tissue cells and near the apices of the villi the cells were so numerous that the cartilaginous character of the tissue was lost.

Cultures from the first case were negative but staphylococcus albus was grown from a piece of the synovial membrane removed from Case 2. I attempted to confirm this finding but bloody fluid aspirated from this joint one week after operation was sterile so it is probable that the first culture was contaminated.

Upon searching the literature I find that the belief that contusion of the articular cartilage may result in chronic progressive arthritis of the injured joint is not a new one. Budlinger reported 14 cases in which he had operated upon the knee for symptoms which dated from an injury and in which he had found evidence of injury to the articular cartilage. The injured cartilage was excised with a knife and the patients were completely relieved or

markedly improved after the operation. In 12 of these cases the lesion was limited to the articular surface of the patella and in 2 there was also a lesion on the external condyle of the femur. Budlinger found that the cartilage was split in an irregular manner and in some instances smaller clefts radiated from the larger ones while in others the cartilage adjacent to the margins of the clefts was loosened from the underlying structure and had a curled a flap like appearance and in 1 recent case there was a hemorrhage beneath the articular cartilage. He also noted that the synovial membrane and fat pad were thickened in many of his cases. Budlinger concluded that traumatic splitting of the cartilage is the most frequent injury of the knee joint and that many cases heal spontaneously but that in a certain percentage functional disturbances develop (when the cartilage flaps are elevated when the clefts are wide and a chondritis develops in their vicinity or when a part of the cartilage is set free in the joint). He described the clinical picture but stated that the diagnosis could be made only by an exploratory operation and he recommended excision of the injured cartilage.

Ludloff reported a similar case in 1910 and Ahausen reported 1 case in 1922. Laeven reported 14 cases and his conclusions were similar to those of Budlinger but he went a bit further and considered the removal of the injured cartilage as an early operation for



Fig. 3. Cartilage from Case 2. Left, surface degeneration with fibrillation. Right, surface proliferation and fibrosis forming a small sessile villus.

arthritis deformans. Koenig stated that he had operated upon 7 similar cases and agreed with Laewen in that the operative removal of the fissured cartilage was a prophylactic measure in the prevention of arthritis deformans.

When I operated upon these two patients I was not familiar with the German literature on the subject and was very hesitant about excising the areas of damaged cartilage because I have always treated this tissue with great respect and in operations upon joints have meticulously avoided injuring the articular cartilage in any way. I have even reported experiments in which the resection of a relatively large rectangle of cartilage from the patellar surface of the femur of rabbits resulted in a progressive arthritis in about sixty per cent of the operated knees (Key).

Consequently I had no desire to perform the same experiment on a man but there seemed no alternative as the cartilage in the damaged area was necrotic and the necrosis seemed to be apt to spread.

Furthermore Dr. Walter Bauer had not been able to confirm my experimental results on rabbits (personal communication) and I had also found that removal of a rectangle of cartilage from the patellar surface of the femur in cats did not cause arthritis and that

similar operations on dogs resulted in mild hypertrophic changes in only an occasional animal. Consequently I hoped that the defect would heal with a fibrous or cartilaginous base and that a progressive arthritis would not develop in the knee. In the second case I was much more radical partly because of my experience with Case 1 and partly because the knee was so badly damaged that all I hoped to obtain was a stable painless joint with about 60 degrees of motion.

Six years ago I removed an old chronic internal semilunar cartilage from a young surgeon. The anterior end of the cartilage was torn and enlarged to about three times its normal size. On the condyle of the femur opposing the knob-like end of the torn semilunar there was an area about 1.5 centimeters in diameter in which the articular cartilage was thinned, roughened, and velvet like in appearance, but not gray and necrotic. Recently I questioned this patient and he states that he has had no trouble with the knee since recovering from immediate effects of operation.

It is thus evident that a joint may return to an apparently normal condition after a contusion and gross injury to the articular cartilage. On the other hand the two cases which I am reporting in this paper indicate that such an injury may lead to a chronic



Fig. Synovial membrane from Case showing villus formation, synovial hyperplasia, and infiltration of the subsynovial tissues. Photomicrograph on the right shows fibrin in the joint cavity and adherent to the surface.

The articular cartilage from Case 2 was also necrotic and degenerating and its surface was broken by numerous clefts, some of which extended down to the zone of provisional calcification, but it contained many areas in which the cartilage cells were increased in size and number and had formed small cell nests. The villi which sprang from the articular surface were composed of an avascular tissue which resembled both hyaline cartilage and connective tissue. The stroma was for the most part hyaline, but the cells resembled small connective tissue cells and near the apices of the villi the cells were so numerous that the cartilaginous character of the tissue was lost.

Cultures from the first case were negative, but *staphylococcus albus* was grown from a piece of the synovial membrane removed from Case 2. I attempted to confirm this finding, but bloody fluid aspirated from this joint one week after operation was sterile, so it is probable that the first culture was contaminated.

Upon searching the literature I find that the belief that contusion of the articular cartilage may result in chronic progressive arthritis of the injured joint is not a new one. Budinger reported 14 cases in which he had operated upon the knee for symptoms which dated from an injury and in which he had found evidence of injury to the articular cartilage. The injured cartilage was excised with a knife and the patients were completely relieved or

markedly improved after the operation. In 12 of these cases the lesion was limited to the articular surface of the patella and in 2 there was also a lesion on the external condyle of the femur. Budinger found that the cartilage was split in an irregular manner and in some instances smaller clefts radiated from the larger ones while in others the cartilage adjacent to the margins of the clefts was loosened from the underlying structure and had assumed a flap-like appearance and in 1 recent case there was a hemorrhage beneath the articular cartilage. He also noted that the synovial membrane and fat pad were thickened in many of his cases. Budinger concluded that traumatic splitting of the cartilage is the most frequent injury of the knee joint and that many cases heal spontaneously, but that in a certain percentage functional disturbances develop (when the cartilage flaps are elevated, when the clefts are wide and a chondroma develops in their vicinity or when a part of the cartilage is set free in the joint). He described the clinical picture, but stated that the diagnosis could be made only by an exploratory operation and he recommended excision of the injured cartilage.

Ludloff reported a similar case in 1910 and Axhausen reported 1 case in 1922. Laewen reported 13 cases and his conclusions were similar to those of Budinger, but he went a bit further and considered the removal of the injured cartilage as an early operation for



Fig. 3. Cartilage from Case 2. Left, surface degeneration with fibrillation. Right, surface proliferation and fibrosis forming a small serrile villus.

arthritis deformans. Koenig stated that he had operated upon 7 similar cases and agreed with Laewen in that the operative removal of the fissured cartilage was a prophylactic measure in the prevention of arthritis deformans.

When I operated upon these two patients I was not familiar with the German literature on the subject and was very hesitant about excising the areas of damaged cartilage because I have always treated this tissue with great respect and in operations upon joints have meticulously avoided injuring the articular cartilage in any way. I have even reported experiments in which the resection of a relatively large rectangle of cartilage from the patellar surface of the femur of rabbits resulted in a progressive arthritis in about sixty per cent of the operated knees (Key).

Consequently I had no desire to perform the same experiment on a man but there seemed no alternative as the cartilage in the damaged area was necrotic and the necrosis seemed to be apt to spread.

Furthermore Dr. Walter Bauer had not been able to confirm my experimental results on rabbits (personal communication) and I had also found that removal of a rectangle of cartilage from the patellar surface of the femur in cats did not cause arthritis and that

similar operations on dogs resulted in mild hypertrophic changes in only an occasional animal. Consequently I hoped that the defect would heal with a fibrous or cartilaginous base and that a progressive arthritis would not develop in the knee. In the second case I was much more radical partly because of my experience with Case 1 and partly because the knee was so badly damaged that all I hoped to obtain was a stable painless joint with about 60 degrees of motion.

Six years ago I removed an old chronic internal semilunar cartilage from a young surgeon. The anterior end of the cartilage was torn and enlarged to about three times its normal size. On the condyle of the femur opposing the knob-like end of the torn semilunar there was an area about 1.5 centimeters in diameter in which the articular cartilage was thinned, roughened and velvet like in appearance, but not gray and necrotic. Recently I questioned this patient and he states that he has had no trouble with the knee since recovering from immediate effects of operation.

It is thus evident that a joint may return to an apparently normal condition after a contusion and gross injury to the articular cartilage. On the other hand the two cases which I am reporting in this paper indicate that such an injury may lead to a chronic

progressive arthritis and in looking back I can recall other cases in which I believe an arthritis resulted from a contusion of the articular cartilage. Why one patient develops a chronic arthritis while another has no symptoms after a similar anatomical lesion I do not know.

Kulowski has reported three similar cases which were relieved by removal of the injured cartilage.

#### CONCLUSIONS

Contusion of the articular cartilage may heal without symptoms or may lead to a chronic arthritis in the injured joint.

When arthritis follows such an injury the joint should be opened and the degenerating cartilage should be excised.

#### REFERENCES

1. AUCHINCLOSS, G. Pathogenesis of arthritis deformans. Arch. f. Orthop. 1922, xx, 1.
2. BUDENSKI, KONRAD. Loosening of joint tissues and resulting phenomena. Deutsche Ztschr. f. Chir., 1906, p. 81.
3. Idem. Traumatic cartilage fissuring in the knee joint. Deutsche Ztschr. f. Chir. 1906, xcii, 510.
4. KIRY, J. A. Experimental arthritis: the changes in joints produced by creating defects in the articular cartilage. J. Bone & Joint Surg. 1931, xiii, 725.
5. KOENIG, G. Arthritis deformans and surgery. Mäenchen med. Wchnschr. 1928, lxxv, 32.
6. KULOWSKI, J. Chondromalacia of the patella. J. Am. M. Ass., 1933, c, 1837.
7. LAZARUS, A. Cartilage resection after fissuring and degeneration of the cartilage of the patella as early operation for arthritis deformans. Beitr. z. klin. Chir. 1925, cxxiv, 265.
8. LUDLOW, Pathology of the knee joint. Verhandl. d. deutsch. Gesellsch. f. Chir. 1910, xxxix, 273.

# CLINICAL SURGERY

FROM THE DEPARTMENT OF CLINICAL SURGERY, UNIVERSITY OF EDINBURGH

## RADICAL EXCISION OF THE BREAST

JOHN FRASER M.D. Ch.M., F.R.C.S. (Edin.) F.A.C.S. EDINBURGH, SCOTLAND  
*Regius Professor of Clinical Surgery*

THE operation for radical removal of the breast and its associated structures as practiced for malignant disease has become a standardized procedure. Opinions may differ on certain details of extent and technique, but taken as a whole, there is a considerable measure of uniformity and in general the principles are accepted that the operation to be effective shall include removal of (1) a skin area which includes the nipple, plus a sufficiency of the same tissue overlying the tumor, (2) the subcutaneous tissue covering the chest wall the mammary gland forming the center of the subcutaneous area ablation (3) the greater and lesser pectoral muscles, with the exception of the uppermost fibers of the former muscle, where they pass from the front of the inner two-thirds of the clavicle (4) the fascial structures in relation to the lateral chest and upper abdominal areas (5) the various groups of lymphatic glands which lie in association with the mamma, and to which malignant cells may be borne.

A summary of this kind indicates that the operation is one of considerable extent and so in fact it is, yet the mortality is surprisingly small, and with reasonable care there are virtually no complications to mar the postoperative progress of the case.

### INDICATIONS FOR OPERATION

In general it may be said that the indications for operation are such breast diseases as are definitely malignant or which show a histopathology of a borderline type. It is true that there are cases in this category which are treated by radium or by X ray therapy but the majority of surgeons will agree that the results of the radical operation for malignant disease are so good that the procedure is likely to remain the method of choice for some considerable time to come. If we are to look at the question from the point of view of contra indication to the radical operation we may say that there are only two contra

indications—the extent of the tumor whether local or by metastases and the general condition of the patient.

### PRE-OPERATIVE DETAIL

Apart from the preparation which is common to all operative interference of a major nature there are one or two details of special significance in breast surgery. The first concerns the question of case investigation and it is that care should be taken to extend the examination beyond the breast and its related parts, and to bring under review by radiographic and clinical examination the condition of the mediastinum, the vertebral column and the abdominal area. In certain instances these areas are the sites of secondary deposits at a comparatively early stage in the history of the case, and it is obvious how unfortunate the position would be if their existence were overlooked.

The second detail is in relation to the matter of skin preparation. Because of the difficulty in securing a satisfactory sterilization of the axillary skin all breast cases demanding the radical operation should undergo a careful skin sterilization over a period of 48 hours prior to the operation, special attention being paid to the preparation of the axillary area. Similar care is demanded in that part of the preparation which immediately precedes the operation. The skin incision is an extensive one a relatively large amount of tissue area is exposed to the possibility of infection and peculiar care must, therefore, be exercised in securing a widespread and thorough skin disinfection. It is advisable to prepare an area which extends from the base of the neck to the umbilicus, and from the nipple of the opposite side to the line of the vertebral column.

### THE OPERATION TECHNIQUE

The patient lies on her back with the head and shoulders slightly raised. In order to open up the axilla the arm of the affected side is abducted



Fig. 1 The outline of the skin incision as employed when the disease occupies a central position in the breast.

until the hand is above the level of the head, the arm being held in this position by an assistant. In order to lessen the amount of seepage which is likely to accompany the operation, a roll of sterile wool covered with a gauze towel is placed beneath the axilla and behind the lateral surface of the chest wall.

The type of skin incision will vary according to the situation and the extent of the tumor but in the majority of cases the most suitable incision is one which crosses the center of the axilla postero-anteriorly and thence extends obliquely downward across the breast to beneath the costal margin on the opposite side separating at its center so as to include the nipple and a sufficiency of skin overlying the tumor (Fig. 1). In order to lessen the possibility of surface recurrence a wide area of cutaneous tissue should be removed and it is our practice to extend the incision a distance of at least 5 centimeters beyond the outermost limit of the tumor area. It may be said that this will result in inability to close the wound in a proportion of the cases, but it is infinitely preferable to leave an open surface which will close by granulation or by grafting than to invite the likelihood of a skin recurrence.

**Dissection of the axilla.** The skin incision having been outlined in a superficial fashion, that portion of it which overlies the axilla and the anterior axillary wall is deepened, and the edges reflected so as to afford access to the axilla and its contents. It is our practice to complete the axillary dissection up to a point before removing the breast and pectoral muscles, for the reasons that such a procedure permits a block dissection by which glands, fascia, and muscles are removed in continuity the vascular supply to the muscles is more easily and efficiently controlled and the removal of the pectoral muscles (the portion of the operation which entails the maximum amount

of shock) is delayed until the end of the procedure.

The edges of the axillary portion of the incision having been reflected, the boundaries of the base of the axilla are brought into view and by sharp dissection these boundaries are revealed as the lower edge of the pectoralis major anteriorly and the lower edge of the latissimus dorsi posteriorly. The base of the axilla space is covered over by the axillary fascia, and this is pierced by the finger immediately behind the boundary of the great pectoral muscle. The dissection is now carried to a higher level. By separation and retraction of that portion of the skin incision which passed over the pectoral muscle the line of separation between the clavicular and sternal fibers of the muscle is defined. Opening up the separation by retraction the costo-coracoid membrane comes into view and coursing over its center in a vertical direction is the leash of the acromio-thoracic (thoraco-acromial) vessels, accompanied by the external anterior thoracic nerves. These structures enter the deep surface of the pectoralis major muscle, and at this stage it is convenient to divide the vessels between ligatures and to sever the nerves (Fig. 2).

The finger of the operator is now passed through the plane of separation and beneath the pectoralis tendon until it appears in the axilla. The segment of muscle thus isolated is divided close to its insertion into the outer lip of the bicipital groove of the humerus, and retraction of the central divided end affords a partial exposure of the anterior aspect of the axilla (Fig. 3). The pectoralis minor and the outer half of the costo-coracoid membrane are now in view. The upper edge of the muscle is separated from the membrane, and at the lower edge of the muscle the muscular branch from the long thoracic artery is ligatured. The tendon of the muscle is now defined and divided close to its insertion into the anterior border of the coracoid process of the scapula. Further retraction of the ends of the severed muscles opens the axilla to such an extent that dissection can be proceeded with (Fig. 4). This dissection is best accomplished by means of a pledget of gauze. Beginning immediately beneath the clavicle on the outer surface of the first rib this type of gauze dissection removes the fat and cellular tissues which surround the axillary vein and is continued peripherally until the whole extent of the venous trunk is exposed. The various junctional vessels—superior alar and long thoracic—are divided between ligatures close to the parent trunks, the subcapular vessels lying at the periphery of

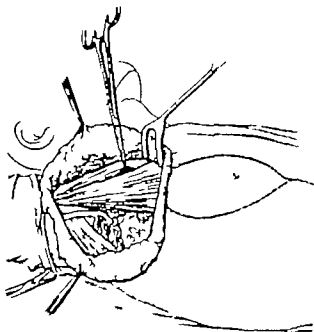


Fig 1. The first stage of the axillary dissection. The separation between the sternal and the clavicular fibers of the pectoralis major muscle is defined, and in the space the thoraco-acromial vessels are isolated and ligatured.

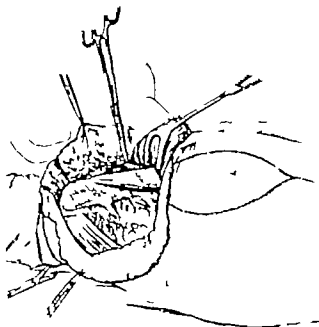


Fig 3. The fibers of the pectoralis major muscle have been divided, and the central portion is retracted. The pectoralis minor muscle is in view. The thoraco-acromial vessel is seen piercing the costo-coracoid membrane at the upper edge of the muscle.

the dissection being retained (Fig 5). The result of this procedure will be to separate a mass of glandular fatty and cellular tissue which is dissected off the posterior wall of the axilla and carried inward toward the lateral chest wall. While this is being achieved certain anatomical structures are encountered—the intercostobrachial nerve, the lateral branch of the second intercostal nerve which is divided where it leaves the lateral chest wall and at the point of entrance into the arm and the three subscapular nerves, the short subscapular, the thoraco-dorsal and the lower subscapular nerves which are isolated and preserved. Toward the posterior part of the medial wall of the axilla the long thoracic nerve is exposed and cleared (Fig 6). Where the inferior angle of the scapula comes into contact with the lateral chest wall a venous anastomosis between the subscapular and lateral thoracic vein is encountered and if injured may give rise to troublesome oozing. These details may be said to conclude the preliminary dissection of the axilla, and the parts are covered with a sterile towel soaked in warm saline.

**Exposure of the breast.** The superficial aspects of the breast with its surrounding tissues are now exposed and to do so the long oblique incision is deepened and its edges dissected in such a way that as much subcutaneous fat as possible is left in contact with the mammary area in order to

secure the exclusion of the subcutaneous lymphatic groups. The limits of the subcutaneous dissection extend from the clavicle above to the costal margin and upper abdominal segment below and from the breast of the opposite side to the level of the posterior axillary fold. By this means the anterior surface of the breast and its related structures are fully exposed to view.

The aim is now to remove in one continuous mass the glandular tissues of the axilla, the breast, the greater and lesser pectoral muscles, and the sheet of deep fascia which extends from the edge of the pectoral muscle over the lateral wall of the chest. The fascial dissection is of supreme importance because it is in this structure that many of the deeper lymphatic vessels are distributed. To ensure its removal it is incised along a line which beginning over the upper end of the sheath of the rectus abdominis muscle extends obliquely upward and backward toward the inferior angle of the scapula, over the upper fibers of the external oblique muscle, it then passes upward dividing the fascia overlying the serratus anterior muscle on a vertical plane corresponding to the level of the posterior wall of the axilla and ends at the level of the second rib (Fig 7). The dissected axillary contents together with the divided central ends of the pectoral muscle being held toward the middle line, the operator separates the fascia from the underlying



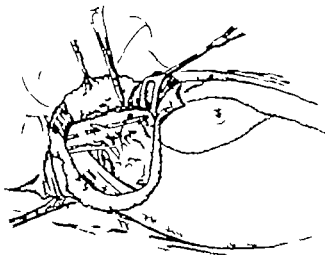


Fig. 4. Both pectoral muscles have been divided and the central ends retracted. The axillary area is now fully exposed to view.

muscles, and, continuing the subfascial dissection forward, the space beneath the pectoralis minor muscle is entered. At this stage the lateral branches of the intercostal arteries perforating the chest wall on a plane corresponding to the anterior wall of the axilla are divided and ligatured. The dissection is thereafter continued beneath the pectoralis major muscle, and as the lateral border of the sternum is reached the anterior perforating branches of the intercostal vessels are isolated, secured, and divided (Fig. 8). The separation is now virtually complete, the attachment of the pectoralis major from the front of the lower half of the sternum is divided, the fascial attachments to the upper portion of the rectus abdominis muscle are severed and there is then removed in a continuous mass a group of tissues comprising the lymphatic and fatty tissue of the axilla, the breast with the greater and lesser pectoral muscles, and the fascial plane of the upper abdominal lower thoracic, and lateral thoracic regions (Fig. 9). It will be observed that the removal of tissues has been achieved by working in the submuscular planes from the lateral to the medial side. By this means there is a reasonable continuity of dissection; the fascial removal is facilitated while the blood supply is easily and effectively controlled. The exposed parts are now covered with warm towels soaked in saline, and the final dissection of the axilla is proceeded with.

*Final dissection of the axilla.* The removal of the breast and the pectoral muscles having afforded free access to all parts of the axilla, a careful survey of the area is made, and all fatty or

fascial tissue which might harbor malignant cells is most scrupulously removed. The spaces around the axillary vessels and the cords of the brachial plexus are cleared; particular attention is paid to the apex of the axilla, and to the space behind the subclavius muscle. A line of fatty tissue following the course of the posterior thoracic nerve demands attention. The fascia which covers the muscles forming the floor of the axilla is dissected off the underlying structures, and the various subcapular nerves are isolated and cleared. The subcapular vessels, and particularly the circumflex scapular branch, around which lymphatic tissue may be deposited are dissected, and throughout the procedure the aim of the operator is to secure the removal of any fatty lymphatic, or areolar tissue in which malignant cells might be harbored.

*Closure of the wound.* A final survey of the operation field is now made, and, after complete hæmostasis is secured the wound edges are approximated by interrupted sutures of silkworm gut and Michel's clips. Any difficulty in apposition may be overcome by undercutting the skin, or if tension should appear to be unduly great, by the method of cross-scoring first suggested by Charles Mayo. If there be any real difficulty from the point of view of tension it is better to be satisfied with incomplete closure than to risk the complication of sloughing. The open wound area may be grafted at the time of operation, using Thiersch grafts cut from the thigh or abdominal area and held in place by Stent supports, or it may be allowed to granulate and be grafted

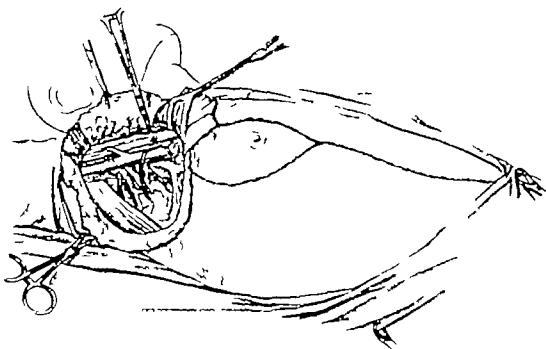


Fig. 5 The dissection of the axilla has been carried a stage further. The main vessels are defined and cleared by gauze dissection while various junctional vessels are ligatured.

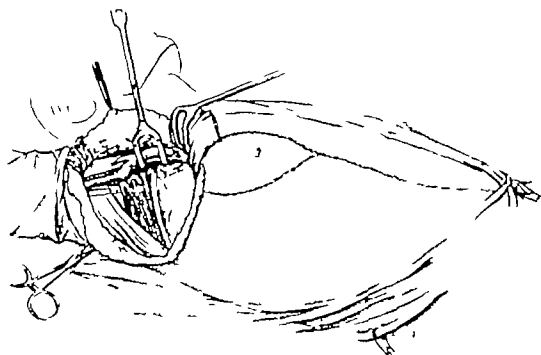


Fig. 6 The preliminary dissection of the axilla has been completed. The various junctional vessels have been ligatured with the exception of the subscapular group, the subscapular nerves are in view and the long thoracic can be seen on the lateral chest wall.

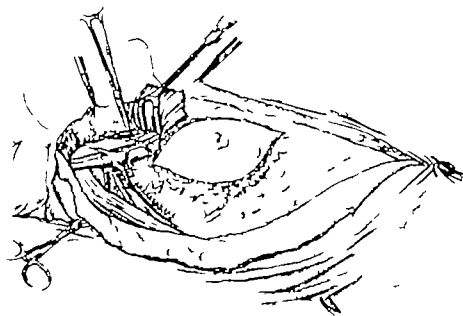


Fig. 7. The exposure of the breast has been secured by dissection of the skin edges, and the limit of division of the fascia has been outlined.

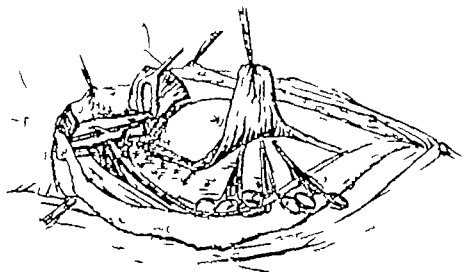


Fig. 8. The subfascial and submuscular dissection is continued. The lateral thoracic vessels have been ligatured, and the anterior perforating branches are being secured.

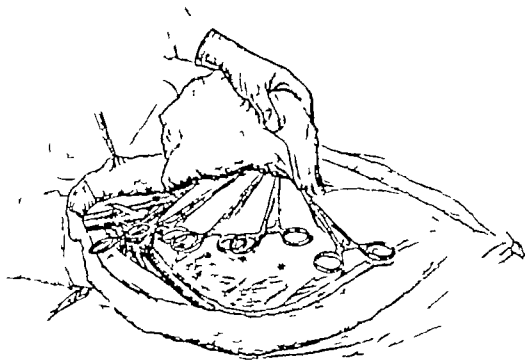


Fig. 9. *The final stage of the submuscular dissection.* The various vessels have been secured, and the muscles are being severed from their sternal attachments.

at a later date. Wound drainage is secured by means of a glass or rubber tube inserted through a stab wound at the dependent part of the dissected area.

#### DRESSING AND AFTER CARE

A large dressing of dry sterile gauze covered with a liberal supply of sterilized cotton wool is applied and care is taken to ensure adequate covering of the more posterior portion of the wound area. A sterile dome-tte bandage holds the

dressings in place and it is so applied that the arm is held abducted at a right angle. When the patient returns to bed the arm is supported on a pillow in its abducted position, and encouragement is given to use the hand and arm. The dressing is changed 48 hours after the operation and at this time the drainage tube is removed. It is usual to remove the clips on the fifth day and the stitches on the eighth day. In an uncomplicated case the patient is able to be out of bed by the tenth day.

## THE Z PLASTIC OR WEB SPLITTING OPERATION FOR RELIEF OF SCAR CONTRACTURES OF THE EXTREMITIES<sup>1</sup>

HUGH T. JONES, M.D. F.A.C.S., LOS ANGELES, CALIFORNIA

THE Z plastic operation is probably an ancient procedure but it is of use in the relief of certain of the residual contractures that have developed from the injuries and burns of modern industry and high speed transportation. Davis has been interested in tracing the history of the use of the Z plastic to 1856 when it was used by Devouilliers. In more recent years particular attention to the procedure has been paid by Davis, Steindler, Kinkadden, and the author. It is a trick that the surgeon must ever have up his sleeve and if remembered when needed, it will often solve a problem in an unexpected way. On the other hand it has very definite limitations and must not be used when other forms of plastic surgery offer more. I first saw the procedure most effectively used by Dr. M. S. Henderson in a burn contracture of the feet and legs of a child. Here the problem was solved in one short operation while, if any other plastic procedure had been used it would doubtless have consumed much time and have necessitated a series of operations (Fig. 3).

It is important to consider the indications as well as the contra indications for the use of the Z plastic operation. It is to be used particularly in the contractures which present a rather extensive web of relatively soft and vascular skin, preferably with subcutaneous tissue. The web must be vascular enough to allow the shifting of flaps without tissue necrosis and elastic enough to accommodate itself to a change in shape that may be required to correct joint contracture. If the scar

ring is too intense and the web relatively avascular leather like, and hard, a postoperative slough may result. On the other hand, even though some of these scars be rather hard and avascular if the flaps are sewed together without undue tension, a slough will not result. One must be careful not to choose the Z plastic operation when a full thickness skin transplant following wide excision of the scar will serve better. Though the Z operation may be found effective at times on the palmar surfaces of the fingers, one is apt to be disappointed by postoperative contractures that reproduce the flexion contracture that the operation sought to relieve. However if it is likely that a certain degree of contracture may be relieved by the Z operation, this procedure may be used as the first step and other means be employed later for further correction, or the Z operation may be supplemented at the time by full thickness skin grafting.

There are other advantages to consider in the choice of the procedure. First, much less time is required for the Z operation than for a full thickness skin transplant or a pedicle graft. Second, the Z operation is much more simple than a pedicle graft of any type and causes much less discomfort for the patient and less effort for the surgeon.

The technical description of the operation is best considered as a series of steps.

1. The web is split into halves (Figs. 1 and 2)

<sup>1</sup>Read before the General Surgery Section of the California Medical Association at the sixty-second annual session, Del Monte, April 24 to 27, 1934. Data and illustrations for the first three cases are from the Mayo Clinic.



Fig. 1 A.

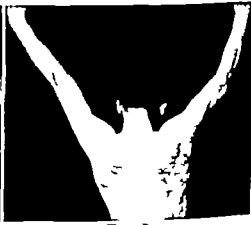


Fig. 1 B.

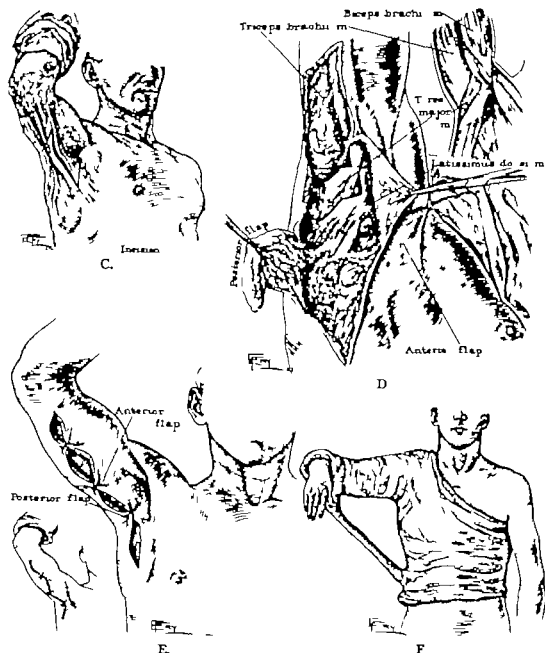


Fig 1 Burn contracture of posterior axillary fold of 18 years duration relieved by Z plastic operation. In A, the muscular young man was abducting to the limit of the contracture. In B, the active range of abduction 30 days after operation is shown. In C, the incision for the Z plastic is shown. The web was cut into an anterior and a posterior flap. The anterior flap was cut away from the side the posterior flap was cut away from the arm. The arm was then abducted but free abduction was found limited by contractures of the teres major and latissimus dorsi muscles. In D is shown the manner of lengthening of the teres major and latissimus dorsi muscles—the band like tendons were cut about half way across from above downward. To gain free abduction, it was also necessary to excise considerable scar tissue in the axilla with due care not to injure vessels and nerves. It is to be noted that the tissue of the web was elastic enough to change shape as required by the new position of the arm and vascular enough to maintain nutrition. In E, it may be seen that the flaps had been trimmed, the anterior flap having been used to cover the defect on the arm and the posterior flap to cover the defect on the side. The scar tissue was excised two-thirds of the way down the arm and hence the long incision is seen in the illustration in addition to the Z plastic proper. In the suturing the main traction points were held by figure-of-eight silkworm gut sutures. Following operation a large dressing of fluffed gauze was applied. In F is indicated the plaster-of-paris cast that was applied to maintain moderate pressure on the field of operation, to afford rest, and to maintain abduction at the shoulder. This type of operation required much less time than a tube pedicle or any other type of repair at hand.



Fig. 2. Burn contracture of entire axilla of 3 years duration, in a boy of 6 years. A shows the pre-operative appearance of the web stretching from arms to chest. The web was fairly extensive and I judged it to be pliable and vascular enough to weather the Z plastic operation. B portrays the portion of the Z plastic incision seen from the front. The web was split along its inferior border into an anterior and a posterior half. The triangular anterior half of the web was cut away from the chest. C shows how the posterior half of the web was cut away from the arm leaving this half of the web attached to the chest wall. D shows anterior flap was wrapped around arm, and posterior flap around chest after arm had been abducted. Correction was maintained by a plaster cast. Slinging appeared in axilla. E shows axillary sling 21 days after operation. On twenty fourth day sling was excised and defect allowed to gape as further correction of shoulder deformity was gained. Moist dressings of bichloride (diluted 1-7) applied until 4 days later when a free, full thickness skin transplant was sewed into place. F diagrams full thickness transplant. G, 46 days after Z plastic operation indicating range of abduction gained as well as skin transplant that supplemented Z plastic.



Fig. 3. Burn contractures of the feet and legs with a web of tissue extending from the dorsum of each foot to each shin. The Z plastic operation was done by Dr. M. S. Henderson, and I, as assistant, was impressed by the marked improvement gained by a simple procedure. It seemed that a prepared puzzle had been solved. A shows the pre-operative appearance and B the situation about 3 weeks after operation. The operation was carried out in the same way as described in Figures 1 and 2. The web was split into two halves, one triangular half of the web was cut away from the foot while the other half of the web was cut away from the leg. Then the one flap was wrapped about the leg and the other flap about the foot after correcting the ankle deformity.

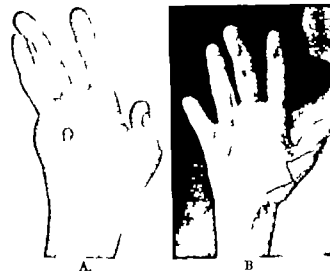


Fig. 4. A boy of 7 years had been burned at 17 months of age and a severe, hard contracture had resulted. A shows the condition of affairs. Particular attention is directed to the web of scarred skin connecting the thumb to the volar surface of the wrist and causing deformity. The little finger was completely covered by scar and held in the palm, the little finger nail alone being free. B, the postoperative appearance is shown particularly to illustrate the relief of the thumb contracture by the Z plastic method. The web stretching from the thumb to the wrist was split along its margin into two halves and the contracture relieved by flap shifting as in the previous cases. This was a welcome procedure at the time because considerable time had been consumed in freeing the little finger and by the full thickness skin grafting for the palmar surface of the fifth finger and the ulnar side of the palm.

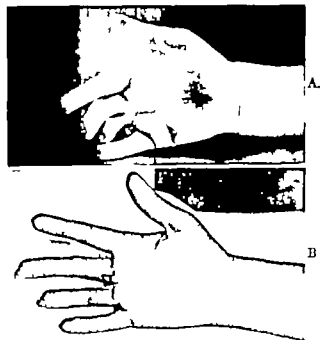


Fig. 5. Burn contracture of fingers of right hand relieved by Z plastic operation supplemented by full thickness skin grafting. A shows a considerable web of tissue connecting the middle finger to the palm. A Z plastic was done and it was learned that when the finger was fully corrected, the triangular flaps of skin were not extensive enough to cover the defect. Additional skin from the abdomen was then used as a full thickness graft to supplement the Z operation on the middle finger. The contracture of the fourth finger was treated by scar excision and a full thickness graft because the web was not extensive enough for the Z plastic operation.

2. One-half of the web is cut away from one limb of the contracture and the other half of the web is cut away from the other limb of the contracture (Figs. 1 and 2). In this way each half of the web becomes a flap to be shifted. One must estimate the degree of correction of the joint con-

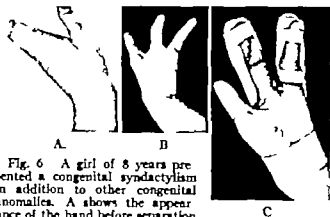


Fig. 6. A girl of 8 years presented a congenital syndactylism in addition to other congenital anomalies. A shows the appearance of the hand before separation of the fingers. In B following separation of the fingers, a contracture is apparent limiting extension of the intervening finger. C shows the appearance about 2 weeks following the Z plastic operation which was carried out according to the same plan as shown in the preceding cases.



tracture to be gained and plan the shape of the flaps to fill the defects. Davis points out that the Z may be reversed if more vascular flaps may be so obtained.

3. The deep contractures must be freed after the incisions are made. Excessive scar tissue must be removed, care being used not to injure important blood vessels or any nerves. It may be necessary to lengthen certain tendons as in Figure 1 D. Of course one should not lengthen flexor tendons of the fingers in the field of this operation.

4. Hemorrhage must be carefully arrested by warm, moist salt packs, very hot packs that may devitalize the avascular skin flaps being avoided. Vessels that require ligation are best tied by fine catgut or better by pieces of split silk that make very small knots and do not irritate as much as large catgut knots.

5. The skin flaps should be protected throughout the operation from chilling and from drying by warm salt sponges. This is easier said than done actually and the surgical nurses should be instructed to help in caring for this part of the work.

6. The flaps should next be trimmed to fit more perfectly the defects that they are to cover. Any cyanotic purple areas indicating regions of defective circulation should be cut away. Davis directs that the points should be made blunt to avoid sloughing.

7. The flaps are sewed into place with figure-of-eight silkworm gut sutures where most stress is to come, the suturing being finished preferably with interrupted horse hair or dermal sutures. Any running suture is not to be used because of the inhibiting effect on the circulation at the edges of the flaps caused by the lock stitch, for instance. There are exceptions to this rule, however, when the time element enters and one must use a lock suture to save time.

8. The field of operation is covered with a quantity of fluffed gauze to help afford even, moderate pressure.

9. A plaster-of-paris cast is applied for three reasons: to maintain correction of the deformity, to exert moderate pressure on the flaps and field of operation, and to afford rest to the field of operation. It is a matter of note that wounds heal well under casts. Casts are superior in this type of work to braces and splints because they cannot easily be removed by the patient or other interested persons; they do not shift and the rest and moderate pressure that is afforded the skin flaps is probably more needed than frequent inspections.

In the postoperative care, the wound should ordinarily not be inspected for 2 weeks and at this time the stitches may usually be removed. The cast may be cut and reapplied as a splint, if it is thought necessary while physiotherapy is being given.

Physiotherapy should consist of infra red rays, great care being used not to burn the flaps that lack proper sensation and circulation. Massage and exercises are to be given as soon after removal of the cast as the condition of the wound will permit.

#### REFERENCES

1. DAVIS, J. S. Arm-chest adhesions: brachiothoracic adhesions, axillary webs. *Arch. Surg.* 1924, viii, 1.
2. Idem. The relaxation of scar contractures by means of the Z or reversed Z type of incision. *Ann. Surg.* 1934, xciv, 871.
3. JONES, HENRY T. Contracture of the axilla from burns: report of three cases. *Minnesota Med.* 1928, April, pp. 210-214.
4. KIRKPATRICK WILLIAM S. Treatment of adherent scars. *California & Western Med.*, 1933, xxxix, 100.
5. STERNBERG, A. A Textbook of Operative Orthopedics, p. 378. New York & London: D. Appleton & Co. 1925.

## OPERATIVE CORRECTION OF THE METATARSUS VARUS PRIMUS IN HALLUX VALGUS

LAUL W. LAPIDUS, M.D., F.A.C.S., NEW YORK

Assistant Adjunct Orthopedic Surgeon, Hospital for Joint Diseases. Assistant Orthopedic Surgeon, Hospital for Ruptured and Crippled

THE enormous wealth and great diversity of the operative procedures devised for the correction of hallux valgus deformity is eloquent proof that this problem is far from being adequately solved. However it is not within the scope of this preliminary communication to go into any review of the very abundant literature on this subject.

The operation for correction of hallux valgus, as given below, is the result of the writer's personal study of this condition. There is no priority or originality claimed by the writer except for the details of the operation as he is fully aware after a review of the literature that there were a few surgeons in this country as well as abroad who had approached this problem in more or less a similar way to the one here presented.

The purpose of this paper is to stress the mechanical importance of the metatarsus varus primus, as one of the most frequent and most prominent factors of the hallux valgus deformity.

The cases of hallux valgus may be classified under three groups.

1. Cases with congenital predisposition toward hallux valgus formation due to metatarsus varus primus. (The deformity may appear in early youth (Fig. 1) and is often hereditary.)
2. Arthritic hallux valgus due to inflammatory peritarsal contractures.

3. Paralytic hallux valgus caused by loss of muscular balance.

It is unnecessary to say that this classification is more or less artificial, and there are possibilities of combinations of any of the features of these three classes in the same case.

The first group is the largest one and the one mainly considered in the presentation.

It is admitted that in the process of phylogenetic development, the *homo sapiens* went through an arboreal stage of life. During this period the foot had to adapt itself to a grasping motion when climbing trees, and therefore resembled the hand—because of greater mobility of the joints and the presence of opposition of the big toe similar to that of the thumb.

Sameness between the hand and the foot is also observed in primates, who use their feet for grasping. In man the foot serves mainly as a supporting limb and therefore the human foot had to

lose its mobility—the hallux becoming strengthened, and the other toes diminishing. The hallux of primates resembles more the thumb, because of its freer range of motion, and the large angle formed by the first and second metatarsals (Fig. 2). To a lesser degree, it may be noted in the human embryo and infants.

Among many changes that took place in the plantigrade human foot due to special demands made upon it in the course of human evolution, there is a marked differentiation between the hallux and the thumb. The first metatarsal in the well developed human foot is nearly parallel to the second (Figs. 3 A and B). Classical paintings and sculpture depict the long and rather narrow foot as an example of beauty and perfection, long before orthopedic surgeons thought of it. Thus it may be assumed that the adult foot presenting marked fan shaped spreading of the metatarsals (*spreiz fuss* of German authors) with a large angle between the first and second metatarsals (metatarsus varus primus), and therefore with a large space between the first and second metatarsal heads, must be considered as an atavistic foot, which never became fully developed. This is a type of foot which most commonly forms a hallux valgus (Fig. 1) and thus the often observed hereditary predisposition toward this deformity can be readily understood.

An excellent illustration of this atavistic type of foot with metatarsus varus primus, presenting congenital potential predisposition toward hallux valgus formation was observed by the author in a case of middle aged brother and sister. The sister developed bunions in young age, as a result of wearing the usual distorting ladies shoes, while her brother's feet remained normal, because of wide, straightlast shoes which checked this potential tendency (Fig. 4, A and B).

The first precursors of incipient bunion as a rule are observed in girls with atavistic foot at the age of about thirteen and fourteen when they first start to wear a narrow pointed shoe with a high heel. The weight bearing is thrown more on the forefoot, and the force of gravity itself tends to produce further spreading of metatarsals and to increase the metatarsus varus primus.

The thumb-like hallux has no room in the narrow and often short shoe. It is gradually de-

tracture to be gained and plan the shape of the flaps to fill the defects. Davis points out that the Z may be reversed if more vascular flaps may be so obtained.

3. The deep contractures must be freed after the incisions are made. Excessive scar tissue must be removed, care being used not to injure important blood vessels or any nerves. It may be necessary to lengthen certain tendons as in Figure 1 D. Of course, one should not lengthen flexor tendons of the fingers in the field of this operation.

4. Hemorrhage must be carefully arrested by warm, moist salt packs, very hot packs that may devitalize the avascular skin flaps being avoided. Vessels that require ligation are best tied by fine catgut, or better by pieces of split silk that make very small knots and do not irritate as much as large catgut knots.

5. The skin flaps should be protected throughout the operation from chilling and from drying by warm salt sponges. This is easier said than done actually and the surgical nurses should be instructed to help in caring for this part of the work.

6. The flaps should next be trimmed to fit more perfectly the defects that they are to cover. Any cyanotic, purple areas indicating regions of defective circulation should be cut away. Davis directs that the points should be made blunt to avoid sloughing.

7. The flaps are sewed into place with figure-of-eight silkworm gut sutures where most stress is to come, the suturing being finished preferably with interrupted horse-hair or dermal sutures. Any running suture is not to be used because of the inhibiting effect on the circulation at the edges of the flaps caused by the lock stitch, for instance. There are exceptions to this rule however when the time element enters and one must use a lock suture to save time.

8. The field of operation is covered with a quantity of fluffed gauze to help afford even, moderate pressure.

9. A plaster of paris cast is applied for three reasons: to maintain correction of the deformity; to exert moderate pressure on the flaps and field of operation; and to afford rest to the field of operation. It is a matter of note that wounds heal well under casts. Casts are superior in this type of work to braces and splints because they cannot easily be removed by the patient or other interested persons; they do not shift; and the rest and moderate pressure that is afforded the skin flaps is probably more needed than frequent inspections.

In the postoperative care, the wound should ordinarily not be inspected for 2 weeks and at this time the stitches may usually be removed. The cast may be cut and reapplied as a splint, if it is thought necessary while physiotherapy is being given.

Physiotherapy should consist of infra red rays, great care being used not to burn the flaps that lack proper sensation and circulation. Massage and exercises are to be given as soon after removal of the cast as the condition of the wound will permit.

## REFERENCES

1. DAVIS, J. S. Arm-chest adhesions; brachiothoracic adhesions; axillary webs. *Arch. Surg.* 1924, vol. 1.
2. Idem. The relation of scar contractures by means of the Z or reversed Z type of incision. *Ann. Surg.* 1931, xciv, 87.
3. JONES, HUGH T. Contracture of the axilla from burns: report of three cases. *Minnesota Med.* 1923, April, pp. 10-114.
4. KIRKPATRICK WILLIAM S. Treatment of adherent scars. *California & Western Med.*, 1933, xxxv, 100.
5. STENHOLM, A. A Textbook of Operative Orthopaedics, p. 38. New York & London: D. Appleton & Co. 1925.

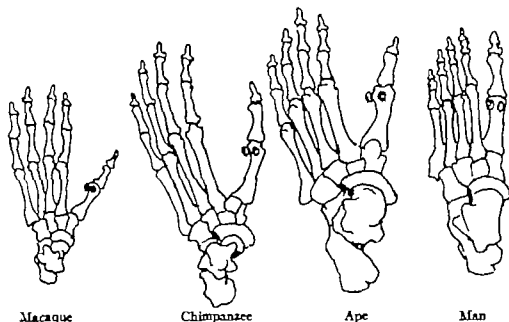


Fig. 2 Note the thumb-like big toe of primates with marked varus position of the first metatarsal. (Adapted with modification from Hiss, J M. *Am. J. Surg.* 1931; 21, 53)

joint. No one would try to correct a knock knee by osteotomizing at the middle of the tibia, or of the femur for example. Therefore, the only mechanically sound osteotomy for correction of metatarsus varus primus should be located at the first cuneiformometatarsal joint, which is the apex of the angulation between the first metatarsal and the first cuneiform.

Without going into detailed description of the anatomy of the region of the first cuneiformometatarsal joint, a few important points should be mentioned. The articulating facets of the first metatarsal and the first cuneiform resemble a lima bean the long axis of which lies in a dorsoplantar direction. The concavity of the bean is toward the second cuneiform—the convexity toward the medial border of the foot. The plane of this joint extends from dorsal, anterior and lateral to plantar posterior and medial directions in other words the articular facet of the first cuneiform, after removal of the first metatarsal will face medially and slightly plantarward. The more medial slanting of the facet of the first cuneiform the more pronounced is the varus position of the first metatarsal.

The occasionally present intermetatarsal articular facet and the lateral dorsal part of the first metatarsal base impinge against the adjacent medial aspect of the base of the second metatarsal and prevents lateral abduction of the first metatarsal toward the second metatarsal. That is why this part of first metatarsal base should be chiseled off in correcting metatarsus varus primus.

The second cuneiform is shorter than the first. Therefore the line of the second cuneiformometatarsal joint on the dorsum of the foot lies about 1 centimeter proximally from the line of the first cuneiformometatarsal joint. The dorsalis pedis artery with its plantar branch passes closely between the bases of the first and second metatarsal bones and should be spared during the operation.

#### DESCRIPTION OF THE OPERATION

The operation is better performed without the use of a tourniquet, as the bleeding is negligible, and it is preferable to control it during the operation.

A longitudinal incision about 5 centimeters long, is made on the dorsomedial aspect of the foot. The incision should correspond to the line of the joint between the first and second cuneiforms. The line of the first cuneiformometatarsal joint should cross the middle of the incision. The tendon of the extensor hallucis longus is retracted medially without opening its synovial sheath. Occasionally it is necessary to lengthen this tendon. The first cuneiformometatarsal joint and the adjacent parts of the bases of the first and second metatarsals are exposed subperiosteally, care being taken not to cut the dorsalis pedis artery and its branches.

The tuberosity of the first metatarsal, impinging against the second metatarsal base, is chiseled off, the plane of the chisel being held parallel with the long axis of the first metatarsal and strictly in dorsoplantar direction (Fig 7 A). The adja-



Fig. 3. A, Long narrow feet. The big and second toes lie close together. B, Roentgenogram of the same feet showing first and second metatarsals almost parallel to each other. This type of foot had no potential tendency to hallux valgus formation. Note that even in this type of foot there is a slight "physiological hallux valgus." Two sisters and father of this patient had also similar type of feet.

cent part of the second metatarsal base is also roughened with a curette.

After that, a small wedge with the base laterally is removed from the articular surfaces of the first metatarsal and the first cuneiform only over their lateral aspect (Fig. 7 B and C). The medial part of the first cuneiformometatarsal joint should be left intact except being denuded from its cartilaginous covering. The base of either wedge removed from the first metatarsal and the first cuneiform should not be wider than about 3 or 4 millimeters each (somewhat more bone should be removed from the cuneiform). The last two points—(1) not to osteotomize the medial part of the adjacent articular surfaces of the first metatarsal and the first cuneiform and (2) not to remove too wide a wedge—are of extreme importance especially the first one. The aim of the operation is to produce a bony fusion of the first metatarsocuneiform joint and adjacent bases of the first and second metatarsals in corrected position. Too large a resection of bone, creating a large gap may be not favorable for bony fusion.

Transverse resection of the whole first cuneiformometatarsal joint (also over its medial part) as advocated by a few surgeons, will produce a shortening of the first metatarsal, causing considerable disturbance of the statics and dynamics of the foot. The first metatarsal bone serves as a medial buttress of the foot, preventing its pronation. The head of the first metatarsal with the underlying two sesamoid bones, is the medial anterior weight bearing point of the foot. Any

GH1



B.

shortening of the first metatarsal, will, therefore, result in an increase of pronation of the foot. Beside that, the second metatarsal head will be much longer compared with the first, and will become the weight bearing point, instead of the first metatarsal head, resulting in pain and formation of tender callosity beneath the anterior arch.

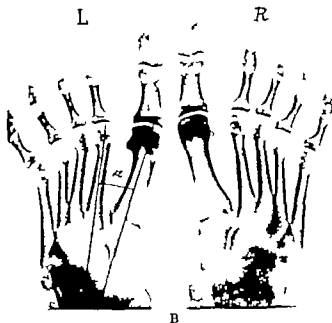
The big toe plays an important part in the process of locomotion. There is a phase in walking and especially in running, when the whole weight of the body is borne by the first metatarsal head, with the big toe in extreme dorsiflexion (Fig. 4 A left foot). Shortening of the first metatarsal will weaken the action of the plantar and dorsal flexors of the big toe, because the distance between the origin and insertion of these muscles will become diminished. This will create some disturbance of gait.

Case 1 serves as a good illustration (Fig. 8). About a year following the operation, the patient developed pain and tender callosities beneath the metatarsal heads, especially the second, and markedly diminished power of motion of the big toe was also observed, as a result of the shortening of the first metatarsal. Thus any operation leading to the shortening of the first metatarsal should be emphatically condemned, because the sacrifice of functional disturbance of the foot is too great a price to pay for cosmetic correction of bunions.



A.

Fig. 4. A Square shaped atavistic feet with widely separated big and second toes. This type of foot has a potential tendency toward hallux valgus formation. The sister



B.

of this man, with same type of foot, developed hallux valgus. Left foot is shown during a phase of gait when the whole weight is borne mainly on the first metatarsal head with the big toe in extreme dorsiflexion. B Roentgenogram of the same feet showing metatarsus varus primus of 13 degrees. Note wide space between big and second toes easily permitting lateral deviation of the big toe in hallux valgus position.

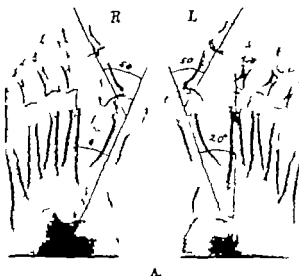
After the resection of the first cuneiformometatarsal joint described the first metatarsal head can be abducted laterally, without much effort, bringing it closer to the second metatarsal head and thereby easily correcting the metatarsus varus primus. The capsule and the ligaments of the first cuneiformometatarsal joint should be preserved as much as possible, especially over its plantar aspect.

Most cases of hallux valgus are also associated with a weak foot presenting flattening of the longitudinal arch and pronation. This is, to some extent, due to the dorsiflexed attitude of the first metatarsal in the cuneiformometatarsal joint. It is advisable therefore when resecting the first cuneiformometatarsal joint, to remove slightly more bone over the plantar aspect of this joint, creating in this way another wedge with a plantar base. The plantar flexion attitude of the first metatarsal is thereby produced and will increase the longitudinal arch and diminish pronation.

A second incision also about 5 centimeters long is made over the dorsomedial aspect of the first metatarsophalangeal joint. The medial part of the joint capsule is bluntly exposed. A tongue-shaped flap with its base attached to the proximal phalanx, is made over the medial part of the

joint capsule. The bony projection over the medial, and often over the dorsal part of the first metatarsal head is chiseled off care being taken to remove all the bony projections interfering with motion of the big toe especially in its dorsiflexion. The adductor tendon and the lateral part of the joint capsule are tenotomized if necessary so that the big toe may now be freely brought in an overcorrected position without using any force. Usually the big toe in hallux valgus has a tendency toward a slight internal rotation, around its long axis so that the nail is facing medially (Figs. 5, A to A). That tendency may be a remainder of opposition of the big toe present in primates and should be taken into consideration during the suturing of the capsule. A heavy chromic mattress suture is inserted first over the plantar distal part of the capsule in front and medially to the tibial sesamoid. The needle is then brought through the dorsal proximal part of the joint capsule and the deep aponeurosis. This suture crosses obliquely the medial part of the first metatarsophalangeal from its plantar and distal toward the dorsal and proximal parts.

After tying of this suture four important points are gained: (1) the big toe is fixed in adduction medially; (2) the internal rotation of the big toe is corrected; (3) the lateral displacement of the sesamoids together with the plantar flexors of the



A.

Fig. 5 A, Case of "bunion" with marked medial protrusion of the first metatarsal head and lateral subluxation of the big toe. Note the lateral displacement of the sesamoids and inward rotation of the big toe, the nail facing



B.

medially. The foot is very wide across metatarsal heads. B Same feet after the operation. Note also the correction of internal rotation of the big toe and practically normal position of the sesamoids.



Fig. 6.



Fig. 7 A

Fig. 6. Imaginary postoperative appearance of the foot in case of successful straightening of the big toe without correcting the metatarsus varus primus. (All relations slightly exaggerated.) Note close resemblance with the foot of phymatous shown in Figure 5. Black area shows the bony prominence which is usually removed.

Fig. 7 Varus position of the first metatarsal is slightly exaggerated for the sake of demonstrability. (The angle between first and second metatarsals is made 30 degrees, while it is seldom over 20 degrees; hallux valgus of 35 degrees is rather common.) Black areas show the parts of bone which are removed. Note the lateral displacement of



Fig. 7 B



Fig. 7 C

sesamoids. A, Lateral part of the base of the first metatarsal impinging against the second, is removed. B, Resection of the first cuneiform-metatarsal joint over its lateral part only. Note that slightly more bone is removed from the first cuneiform. The adjacent part of the second metatarsal base is roughened with a curette. Removal of the bony protrusion over the first metatarsal head and plastic of the capsule over the medial aspect of the first metatarsophalangeal joint. C, Metatarsus varus primus and hallux valgus are corrected. Note the sesamoids returned to their normal location.

big toe is reduced and this reduction maintained (4) the deep dorsal aponeurosis with the extensor hallucis longus tendon is pulled medially preventing lateral displacement of this tendon. The tongue-shaped flap of the capsule is now resutured, with the big toe held in adduction, and slight external rotation. The tendon of the abductor hallucis may also be reattached to the medial flap of the joint capsule, thus providing active force, correcting the hallux valgus deformity. The removal of the lateral prominence of the fifth metatarsal heads may also be indicated in some cases.

The deformity must be entirely corrected by the operative procedure alone, so that the big toe will maintain this correction, even if left unsupported. A tight flannel bandage is applied over the well padded forefoot keeping the metatarsals closely approximated. In about 2 or 3 weeks a plaster-of-Paris casing is applied to the foot maintaining the correction of metatarsus varus primus. The big toe is not included in the casing and its active and passive motion is encouraged.

A few points in pre-operative preparation of the skin are worth mentioning as insuring primary union of the wound. It is advisable to prepare the skin over the 'bunion' by means of shaving off the callosity and applying salicylic acid ointment a few days or sometimes a few weeks before the operation. A very often present, but usually overlooked, trichophytosis of the foot should be cured before the operation is undertaken.

The writer also believes that the often used oval excision of the skin around the 'bunion' should not be practiced as it may cause tension when the skin is resutured and lead to separation and sloughing of the wound edges. No attempt to remove the bursa is made by me as a rule as both the callosity and the bursa readily disappear after the underlying cause—the undue pressure—is eliminated with the correction of the deformity.

It is also important to stress the postoperative care in these cases. A rigid metal plate should be worn by every patient for a few months following the operation as the keystone of the longitudinal arch—the first cuneiformometatarsal joint—is weakened by this operation, and has to be protected until it will regain its strength. Full weight bearing should not be allowed before 6 or 7 weeks in order to insure solid fusion of the resected cuneiformometatarsal joint.

The somewhat prolonged period of postoperative disability and the resection of the joint supporting the longitudinal arch may be considered the weak points of this operative procedure. The

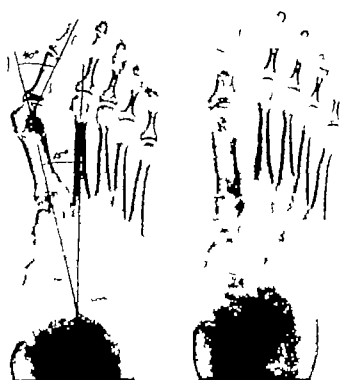


Fig. 8 Case 1: Right foot of girl 21 years old before and after the operation. (Operated upon April 8, 1931.) Excellent correction of the hallux valgus. Note the marked post-operative shortening of the first metatarsal. About one year after the operation this patient developed heavy callosity over the whole anterior arch, which became markedly convexed. There was tenderness over projecting plantarward second metatarsal head. When she stood the big toe was kept above the floor and there was marked loss of power on motion of the big toe. Functional result is therefore considered by the author as unsatisfactory because of shortening of the first metatarsal.

number of cases is too small as yet and the time following the operation too short, to make any definite conclusions. (The first case was operated upon April 8, 1931.) However, the writer feels that both the functional and cosmetic results thus far obtained are more than encouraging and therefore warrants giving this operation further trial in cases of hallux valgus with metatarsus varus primus (Fig. 9, A, B, C, D, 10 A, B).

Not every patient with bunion should be operated upon, operation being limited to cases of functional disturbance or where cosmetics plays an important part. Each case requires individual study.

#### SUMMARY

- 1 In a great majority of cases of hallux valgus, there is metatarsus varus primus, which is the primary underlying cause of the deformity—hallux valgus occurring secondarily because of shoe pressure.

- 2 Hallux valgus, or 'bunion,' is not so much a lateral deviation of the big toe as the medial



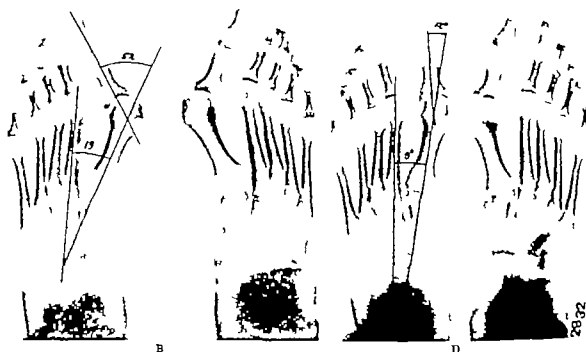
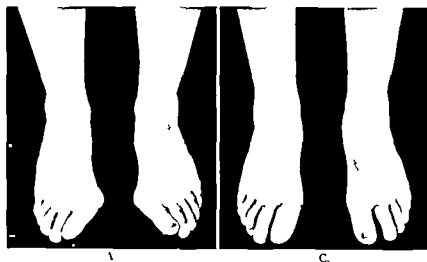


Fig. 9. Case 1. A, Feet of a girl 12 years old. Note that in spite of very marked hallux valgus deformity there is no overlapping of the big and second toes. B, Roentgenogram in the same case showing atavistic feet with metatarsus varus primus of 10 degrees and hallux valgus of 53 degrees. C, Appearance of the same feet 6 weeks after the operation performed on February 3, 1932. Excellent com-

protrusion of the first metatarsal head forming bony proliferation because of constant trauma.

3. There is a type of square foot, with a widely spread metatarsal head and metatarsus varus

metic and functional result. The circumference of the foot across metatarsal heads became about 1 centimeter less than before the operation. D Postoperatively, roentgenogram in the same case. The metatarsus varus primus is reduced from 10 degrees to 9, the hallux valgus from 53 degrees to 2.

primus. This foot closely resembles that of primates and is considered atavistic. In a well-developed human foot, the first and second metatarsals lie almost parallel the latter type very seldom developing bunion."

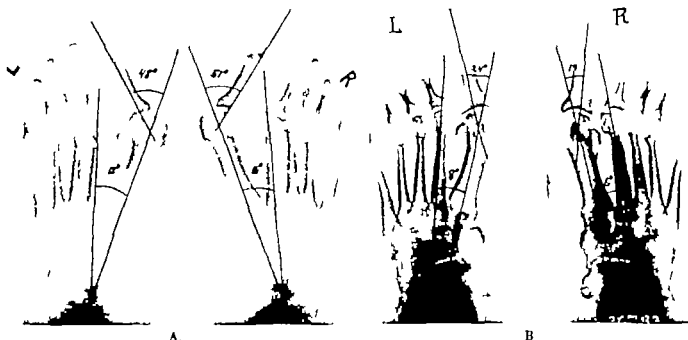


Fig. 10. Case 3. A, Feet of woman 35 years old. Note also dorsal subluxation of the basal phalanx of the right second

toe and the lateral projection of the fifth metatarsal heads. B, Postoperative roentgenogram in the same case.

4. This atavistic foot has a congenital potential tendency toward hallux valgus formation and therefore hallux valgus is often hereditary, appearing in youth, mostly in women, because of their type of shoe.

5. No operative procedure is satisfactory unless correction of the metatarsus varus primus is accomplished.

6. Operation for correction of metatarsus varus primus by resection of a small wedge at the lateral part of the first cuneiformometatarsal joint, is described.

7. Any operation creating shortening of the first metatarsal or the big toe, is emphatically condemned as unphysiological and causing static and dynamic disturbance of the foot.

8. Conservatism and individualization in indication for operative correction of bunion is advocated.

Indebtedness is acknowledged to Dr. Leo Mayer for kind permission to use this operation on his service.

#### BIBLIOGRAPHY

- ERLACHER, P. J. Die Technik des orthopaedischen Eingriffs. Eine Operationslehre aus dem Gesamtgebiet der Orthopaedie. Vienna: Julius Springer, 1928.
- HARR, J. Welche von den zahlreichen Operationsmethoden beim Hallux valgus sollen wir anwenden? *Zentralbl. f. Chir.* 1932, xxvi, 1561-1564.
- HIRS, J. M. Hallux valgus, its cause and simplified treatment. *Am. J. Surg.* 1931, xi, 51-57.
- JUVARA, E. Le Hallux Valgus Son Traitement Operatoire. *Rev. d. Chir.* 1932, li, 322-348.
- KLEINBERG, S. The operative cure of hallux valgus and bunions. *Am. J. Surg.* 1932, xv, 75-81.
- SOUTTER, R. *Technique of Operations on the Bones, Joints, Muscles and Tendons*, p. 118. New York: Macmillan Co., 1917.
- TIMMER, H. Die Behandlung des Hallux valgus. Leipzig: J. A. Barth, 1930.
- TRUSLOW, W. Metatarsus primus varus or hallux valgus. *J. Bone & Joint Surg.* 1925, vii, 68-108.

## THE DIAGNOSIS OF TRICHOMONAS VAGINALIS VAGINITIS

## PRELIMINARY REPORT ON A NEW METHOD

RUTH E. EWING, M.D. AND MARGUERITE LE MOINE, NEW YORK

In recent years the gynecologist has been faced with the ever increasing problem of the diagnosis and treatment of *Trichomonas vaginalis* vaginitis. Undoubtedly this is one of the most frequent causes of leucorrhoea and because of this fact it is of paramount importance to find a simple way of diagnosing and treating this infection.

The usual method of diagnosing *Trichomonas vaginalis* vaginitis is as follows: a drop of vaginal secretion is placed in a drop of normal saline solution on a plain or hanging drop slide; a cover slip is placed over the suspension and the specimen is examined at once under the high power lens of the microscope. Many pus cells, epithelial cells, and innumerable trichomonads are seen. The organism is in constant motion and when free of debris moves very rapidly; if dead it cannot be differentiated from a pus cell.

Although this is a simple procedure, it takes several minutes of the doctor's valuable time, especially when more than one hanging drop of secretion taken from different parts of the vulva and vagina is examined. Often living organisms are not found because the patient has had recent douches or treatments or because lubricant on the examining finger inactivates the trichomonads. A single plain water douche may inactivate the organisms so that a diagnosis cannot be made. In these cases the discharge must be examined repeatedly, preferably after a menstrual period. The patient should not have taken douches or vaginal treatments. In several individuals it has taken months to find live trichomonads in a persistent, profuse vaginal discharge.

In 1932 we began a study of the *Trichomonas vaginalis* vaginitis and many slides were stained according to the Schaudinn's fixation iron haematoxylin method. This procedure is the usual one for staining flagellates, but requires much time and experience. It is almost impossible to complete the staining under 24 hours. Frequently the results are not very satisfactory. However when a good smear is obtained, the details of the trichomonad are well brought out.

Careful study of these iron haematoxylin smears disclosed the fact that the protoplasm, nucleus, and vacuolization were very definite and unchanging. The flagella were not always easily seen, but could be found if carefully studied and frequently

were quite prominent. The *Trichomonas vaginalis* may be pear-shaped, round, oval, or irregular with amoeboid processes. It varies in size from 7 to 30 microns. It has an oval or spindle shaped nucleus, close to the anterior end where four flagella arise. A fifth flagellum can occasionally be seen arising from a blepharoplastic granule. The undulating membrane is not always visible, but arises from the anterior end and extends about half the length of the body. An axostyle may be seen.

In smears from cases of untreated *Trichomonas vaginalis* vaginitis, a large diplococcus was always found covering the entire slide. Gram stained preparations showed this to be a gram positive organism. This gram positive diplococcus often but not invariably disappeared as the patient received treatment and the clinical symptoms improved. The trichomonads decreased rapidly in numbers as treatment progressed.

It has been noticed that trichomonas-like organisms were frequently found in the routine gram stained smears. These organisms showed the body structure of the trichomonad, but were so similar to pus cells that they might easily have been mistaken for them. The large gram positive diplococcus found in these smears was difficult to differentiate from the gram negative diplococcus of gonorrhoea. This difficulty is well illustrated by a case observed during this study.

The patient, a single, 8 year old girl, with a severe acute vaginitis was first seen in a clinic where a microscope was not available. Routine smears were taken and sent to three different laboratories. The reports were variable. One laboratory reported gram negative intracellular diplococci. The second laboratory found gram negative diplococci not definitely intracellular. The third report was negative for gram negative intracellular diplococci. A few days later a hanging drop examination was made and myriads of *Trichomonas vaginalis* were found. Because of the varied reports new smears were taken and some of the original gram stained smears were obtained from the laboratory that had reported them as suspicious. These smears were examined and showed typical *Trichomonas vaginalis* with definite flagella and many gram positive diplococci (Fig. 1). No gram negative diplococci were found. These smears have since been examined by several physicians and technicians who have agreed that the diplococci were gram positive and not gram negative.

The gram stained smears of this patient showed the flagellate so definitely that it was decided that

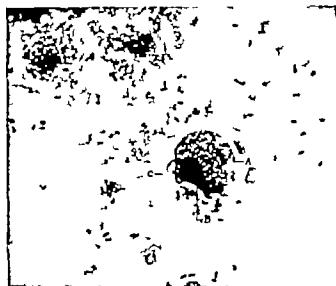


Fig. 1 A Vacuolated protoplasm of *Trichomonas vaginalis* B nucleus C flagella.

If carefully examined, *Trichomonas vaginalis* could be found on a routine gram stained smear.

It was discovered during this study that although the gram stain showed the typical body structure of the *Trichomonas* the flagella were not frequently visible. Many different stains were tried in an effort to bring out the flagella, and finally a dilute carbol fuchsin stain was found that invariably showed the trichomonas flagella and good body detail (Fig. 2). With this stain much of the debris of the smear is washed out, leaving epithelial cells, pus cells, beautifully stained trichomonads with flagella and the ever present diplococci.

The technique of making carbol fuchsin stains is simple and includes the following steps: (1) smears are made thin; (2) they are fixed in air not flamed; (3) the slides are covered with carbol fuchsin (about 20 to 25 drops); (4) 30 drops of distilled water are added and allowed to stand for 3 minutes; (5) the slides are washed with distilled water and dried between filter or blotting papers; (6) examination made under an oil immersion lens.

At the present time two dry smears and a hanging drop are taken in every case. One dry smear is stained by the usual gram stain method and the other by carbol fuchsin. A diagnosis is made from these before the result of the hanging drop, done by another technician, is known. Of 90 smears examined 166 per cent were found positive



Fig. 2 A Vacuolated protoplasm of *Trichomonas vaginalis* B nucleus C flagella.

and 34 per cent were found negative for *Trichomonas vaginalis* of these 90 smears the hanging drop examinations were positive in 41 per cent and negative in 59 per cent. In 8 per cent of the cases no hanging drop examination was made. Positive findings in hanging drop examinations were shown in only 63 per cent of the cases with positive smears.

This preliminary report is offered with the hope that the *Trichomonas vaginalis* may be recognized in an ordinary dry smear stained with carbol fuchsin. It will save much time if a dry smear for diagnosing *Trichomonas vaginalis* vaginitis is taken at the time when the usual smear for gonorrhoea is made. Furthermore the diagnosis of *Trichomonas vaginalis* vaginitis should be more accurate from a dry smear than from a hanging drop because of the possibility of the inactivation of the organism in the suspension.

Further reports will be published of this study as soon as completed. It is hoped that a study of vaginitis in children and the non specific urethritis of men can be included in the next report, and as well the relationship and importance of the gram positive diplococcus that is found in association with the *Trichomonas vaginalis*.

#### SUMMARY

1. *Trichomonas vaginalis* vaginitis can be diagnosed from a dry smear by a simple carbol fuchsin stain.

2. *Trichomonas vaginalis* can be recognized on a gram stained smear, but the diagnosis is not as definite as when the carbol fuchsin stain method is used.

<sup>1</sup>The majority of the smears studied were obtained from the gynecological clinic of the New York Infirmary for Women and Children. Photographs by M. L. Feders of the New York Infirmary for Women and Children.

## INTERNAL FIXATION OF FRACTURES

## A SIMPLIFIED (NEW) METHOD

I BISHOP MUMFORD B.S. M.D. F.A.C.S. INDIANAPOLIS, INDIANA

THE attempt to hold fragments of a fractured bone in position by means of some foreign material dates back over a century from this time. The earlier efforts were made in compound fractures by simple suture with wire and then later in simple fractures by some device which merely penetrated the skin but which did not expose the bone. As surgery developed and the exposure of fractures through open operation became safe, the mechanical center of the surgeon's brain ran unrestrained and many devices, contraptions, and gadgets were suggested for what has become universally called "internal fixation of fractures." It would doubtless be futile to attempt to discard this terminology but it is imperative to emphasize that, in all types and in all forms of "internal fixation," the actual fixation of the fracture is obtained through an efficient external splint. The surgical steps taken relative to the bone are only to obtain an apposition of the fragments and so to suture them that the reduction may be maintained while the external splint is applied and also to some extent to counteract the tendency to displacement along the fracture line which may result through muscular pull and through ordinary movements of the extremity in nursing. That this very important fact is overlooked or considered unessential is shown in the literature as but few writers after describing their method of fixation make any mention of an added external splint. Is it not feasible to state that many of the failures in internal fixation operations have resulted from the lack of external splintage rather than from a defect in that part of the operation directed to the bone alone? Have not many plates and bands become loose and irritating foreign bodies as the result of necrosis due to the added strain thrown upon the fixation device through inadequate external fixation? Is it proper to teach that a fractured leg can be banded and the patient allowed to walk within a few days without additional external support?

## HISTORICAL REVIEW

The earliest reference to the use of wire for suturing a fracture is that of Icart in 1775. Icart had been accused in a letter by Pujol of using a wire on a fractured leg which resulted in

the death of the patient through gangrene 2 days later. Icart in his response to Pujol vigorously denied that he had used wire though he would not have had an objection to it in a fracture in which the periosteum and soft parts had been torn away. He then goes on to state that Lupujade and Sicre of Toulouse had used wire in their fracture work. Pujol replied to this, stating that he had worked as an assistant to these two men and indignantly refuted the statement, saying that they would not be guilty of such! Heard, in 1839, in an article on ununited fractures refers to the fact that Kearny Rodgers had drilled holes in the ends of bones after resection and united the fragments. Pancoast in 1844 in his *Treatise on Operative Surgery* states that wire sutures should not be used in fractures as it causes bone necrosis and, later in his 1853 edition, mentions that wire had been used in fracture work at the Pennsylvania Hospital years ago but with unsatisfactory results. Severine was quoted by Velpau as having suggested in 1839, that a fracture of the patella be wired but that the patient refused the operation. Apparently but little was suggested for many years in the way of methods of holding fractures other than through simple splints. LeMoyné reported in 1879 the successful treatment of an ununited fracture in which he maintained proper approximation of the fragments by means of a "staple" type of clamp and a double splice of wire. In 1878 von Heine used a rather elaborate contraption for holding ununited fractures. In 1840 Flaubert, as quoted by Maligngne successfully united a fractured humerus by passing a metal wire through the ends of the bone. In 1840, Maligngne presented his hooks (Fig. 1) for maintaining apposition of the fragments in a fracture of the patella. These hooks were later modified by Lewis who made them in pairs, by Otis who had the parts adjustable, and by Duplay who used heavier metal. Gaillard in 1865 treated his fractures by means of long screws (Fig. 1) which were passed through the skin and the bone, the shaft of the screw being in silver sheaths as it passed through the soft tissues. In 1886 Blücher used intermedullary plugs and also a special clamp for holding fractures. Wright, in 1885 reported 8 cases in which wire was used as a bone suture. In 1887 Bernays created thin bone

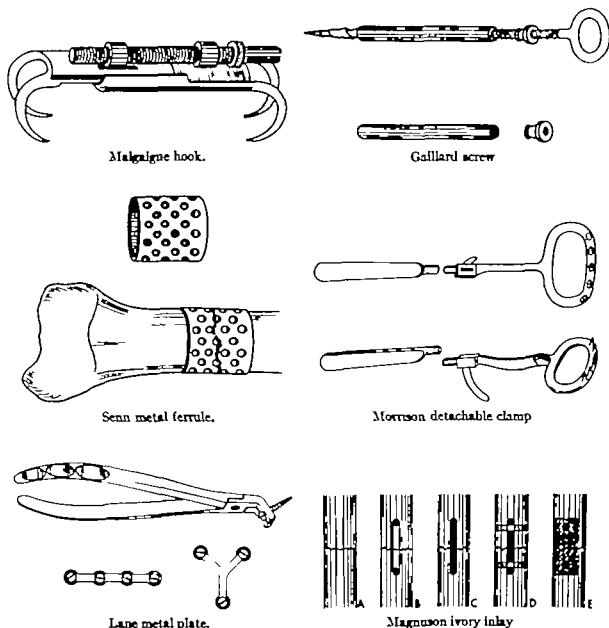


Fig. 1 Different types of apparatus.

plates by implanting bone sawdust into the abdominal walls of a dog and then using these plates about the line of a fracture, the plates being held in place by means of wire. Keetley in 1892 used adjustable staples which transfix the bone and then were fixed externally in the plaster splint. Senn in 1893 suggested the use of a perforated ferrule (Fig. 1) over the fracture line. Thiriar reported, in 1894, 2 cases of pseudo-arthritis in which he used with success aluminum plates fixed by screws. He stated that Quénu of Paris had used such plates in 1891. Estes (33) in 1896 reported the use of steel plates of his own devising which were held in place by means of ivory pegs and that he had used this method of fixation of

fractures since 1887 and also mentions that Schede of Hamburg had used similar plates at an earlier date. In 1900 Streinach reported his method in which silver plates were used. Annandale described in 1897 his pin method and in 1902 Lambotte reported his work with transfixation screws held together by means of an external plate (Fig. 2) and in 1909 Morrison published his article describing a special bone clamp with detachable handles (Fig. 1).

Until Lane (63) in 1905 (Fig. 1) gave out his work on the use of metal plates fixed to the bone with metal screws and described his technique of operating the use of metal for fixation of fractures had been more or less sporadic and sug-

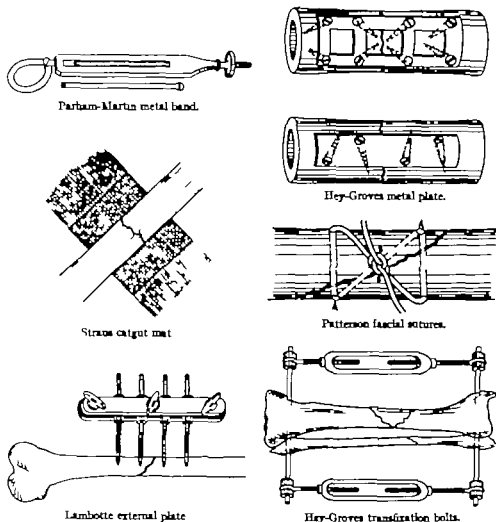


Fig. 2.

gested by only a few operators. Lane not only stimulated open reduction of fractures by showing that it was a comparatively safe procedure so far as infection was concerned but also satisfied to a large degree the surgical world that the use of metal in the line of fracture did not prevent normal bone healing. The pendulum swung far, and Lane plates became a part of the surgical equipment of every hospital and a text on fractures was not complete without a full picture of the different size Lane plates and the special tools for their application. In 1912 further stimulus was given the subject of internal fixation of fractures through the writings of Buchanan, Sherman, Hey-Groves (51) and Allen (3) to be followed the next year by the reports of methods by Scuttler Magnuson (Fig. 1) and Freeman (38). It

was for the year 1914 that the literature reserved its full glory of new ideas in fracture work. Milnes (84), Puttl, Parham (85) (Fig. 2), Brougham, Davison, Straus (Fig. 2) and many others made their reports. New devices, new material, and newer improvements! The year 1916 too, had its share of contributors to this subject in the articles by Hawley, Lathrop, Kane, Grant, and Roberts, in 1919 Collins (20) and Bell in 1920, Hughes, and Smith and, in 1924, Elsson wrote of their experience with internal fixation methods. In 1927 Digby and Trojan started a fresh outburst of writings upon open operation of fractures for in 1928 Juvara, Hendon, Patterson (Fig. 2) and Cucullu added articles to the literature to be followed in 1929 by those of Henderson, Greenwood, Bailey and Allen (4) and in the next 2

years Dahl Iverson, Conn Pitkin, Carrell, and Knickerbocker added their contributions to the subject (Apology is made to those many tens or even hundreds of authors whose writings have been apparently overlooked in this review.)

At the first glance of the literature on the subject of internal fixation of fractures the problem would seem very complicated. A more careful analysis, however, makes it possible to simplify the matter and the confusion of so many methods (the writer was able to isolate 62 different methods or modifications of methods from the articles reviewed and many more have been presented only through the literature of the instrument maker) resolves itself into two general underlying principles, that of the use of an absorbable material and that of the use of a non-absorbable material. In each group there is one common factor, the use of a material which is foreign to the body tissues (with the exception perhaps of those who use autogenous bone or fascial sutures for fixation purposes). It is obvious that those who use a material which is absorbable must place that material in contact with the bone and that the soft tissues are closed. To those who use non-absorbable material is offered the plan of buried material (bands, plates, etc.) which should be removed by a second open operation or the plan of devices which transfix the bone and extend through the skin that they may be removed without further operative work (long screws, transfixation pins, special clamps, etc.)

#### OPEN REDUCTION OF FRACTURES

It may be noted as a maxim that in fractures of the long bones, an earnest effort should first be made to obtain reduction through simple or closed operation and open reduction be done only after the simple method of reduction has failed to give a position satisfactory for good function. This does not necessitate a perfect position of the fragments as shown in the X ray.

Fractures of the patella and olecranon with wide separation of the fragments, fractures of the tibial condyles with a disturbance in the joint level fractures of the vertebrae with cord lesions, certain fractures of the ulna and radius (upper fourth) fractures about the joints with small fragments displaced (elbow) and some depressed fractures of the skull constitute a group of bone lesions in which open operation is the only plan of treatment and should be done early.

With the better understanding of skeletal traction and the use of the fluoroscope in closed reduction, the indications for open reduction are becoming less frequent. However with better sur-

gical technique the dangers of exposure of the fracture line are so minimized that one should not hesitate to open a fracture in order to obtain that position which will give the best functional result. It should be noted that an open reduction will, in the majority of cases, lengthen the time for complete healing of the fracture.

#### THE REACTION OF BONE TO METAL

The effect of metal on bone and on the formation of callus and on the eventual healing of fractures has been a subject of considerable study and discussion, with the question still one of dispute and controversy. Zierold quotes the work of Levert who made experiments upon dogs to determine the tolerance of bone and soft tissues to metal sutures. He used gold, silver lead and platinum, finding the latter to be the least irritating.

Leriche and Policard (also quoted by Zierold) conclude from their studies that by histological examination and chemical analysis of the tissues involved, not only was the bone adjacent to a buried steel plate necrotic and rarefied but that there likewise occurred a marked impregnation of the underlying structures with iron salts. Mann found only a slight rarefaction around steel nails and screws at the end of 4 weeks.

Hey Groves (52) in a large series of experiments, came to the following conclusions: (1) nickel plated steel has no irritating effect upon tissues; (2) magnesium is rapidly absorbed and acts as a powerful stimulant to bone formation; (3) indifferent aseptic foreign bodies are readily tolerated by the tissues.

Zierold's conclusions in his own work are summarized thus: (1) Gold, aluminum and stellite are readily tolerated by bone and tend to become encapsulated with but little hindrance to the reparative processes. They are inert materials unaffected by the living cells and body tissues. (2) Silver and lead are only slightly less tolerable to bone but are easily corroded and evoke a slightly greater connective tissue response. (3) Zinc goes into solution readily and causes a slight connective tissue stimulation. (4) Copper causes definite stimulation to bone production. (5) Copper aluminum bronze frankly interferes with bone regeneration and tends to become extruded. (6) Steel, and, to a less degree, iron definitely inhibit bone regeneration. Steel which is poorly tolerated and readily soluble seems least suitable for all bone prothesis. He differs with the findings of Hey Groves in that (1) nickel has a distinctly injurious effect upon bone growth and that it is soluble in the tissues which make no attempt to



retain it and (2) that magnesium is a slight connective tissue stimulant and if anything tends to retard bone proliferation.

Brickner gives the following deductions: (1) A metal plate screwed to a fractured bone can, of itself, cause delayed union and non union and (2) neither a  $3\frac{1}{4}$  inch metal plate nor an additional well applied plaster-of-paris splint can be depended upon to maintain alignment of a fractured shaft in a very muscular thigh.

Magie states that a metallic band causes an excessive callus, and Stanley and Gatellier also found the same reaction to metal bands. In the use of metal plates fixed with metal bands they found the latter were not incorporated in the callus formation. Leriche and Pollard (71) in 1920, studied 15 cases of osteosynthesis by means of Lambotte's plates. Microscopic examination showed a certain amount of fibrous tissue external to the plate. Around the plate was at times noted a sheath of new bone while beneath the plate the bone immediately subjacent is dry, white and avascular. If the plate were removed early (20 to 30 days) they found an extremely thin lamelliform sequestrum. Further study showed an ischemic necrosis and, deeper the bone in a process of rarefaction. The central callus was slow to appear and poor at that and the tissues impregnated with iron salts. Millet had somewhat the same findings. He attributes the superficial necrosis to ischemia produced by compression and the destructive action of the body fluids attacking the metal.

Cunéo and Rolland found that organic salts formed about metal but that it had no deleterious action upon the tissues, bony or otherwise. Young stated that plating does not prevent delayed or non union and suggested that the periosteum be reflected from that area to which plates are applied in order to encourage callus formation. Relative to the use of plates Frank gave these conclusions after a review of the literature upon this subject: (1) Plates do not always fix the fragments as the screws are often enough loosened by aseptic rarefying osteitis. (2) Plates do not act as treble work. On the contrary they cause destruction of the adjoining osseous tissues. (3) Plates do not stimulate osteogenesis but he believes that the primary firm fixation is a distinct hindrance to new bony growth. (4) There are too many unfortunate sequelae resulting from bone plating such as persistent sinuses and the stiffness in neighboring joints.

Freeman (38) believed that the presence of a foreign body near the line of fracture favored delayed union or non-union, to say nothing of infec-

tion. He quotes Martin thus: "As a rule the presence of a plate instead of stimulating osteogenesis between broken bone ends retards it. Lathrop was led to the use of the sliding graft through his experience with plates which required removing or caused non-union softening and necrosis. Harrigan advocates the use of plates in certain types of fractures but feels that the ideal fixation apparatus is one made of an absorbable material. He admits the validity of the objections to the use of plates in that they delay callus formation and bone union. Bartlett at first was enthusiastic about the use of metal plates but, after reviewing 38 cases in which the plate was removed in 13 cases and 7 cases had failure and also finding that in the course of time bone in contact with metal disappeared is now more conservative in their use.

Albee Hensert Lexter Henderson Harrigan, Frank, Freeman (39) Lathrop object to the use of metal plates and for the most part to the use of metal in any form for fracture fixation. Sherman, Lane (64) Hey-Groves, Ellason, Ashhurst, Hallopeau, Dujarier, Fredet, and Algrave on the other hand, form a group who have used metal plates extensively and with gratifying results. Many surgeons who object to the use of plates but not to the use of metal have developed their own special devices of bands, clamps and transfixation pins with external plates.

#### FIXATION DEVICES AND APPARATUS

In the earlier years of surgery but little attempt was made to do any open reduction of fractures on account of the danger of infection. Malgaigne (Fig. 1) invented his hooks for drawing together the separated fragments of a fractured patella which device was later modified by Béranger and also by Rigaud. In 1878, von Heine published his results with a rather complicated apparatus which evidently did not meet with approval. Gaillard (Fig. 1) in 1865, used a long screw extending through the skin and transfixing the bone along the line of bevel of the fracture. These screws were removed after healing of the fracture.

In later years open reduction of simple fractures was proved to be a safe procedure and the use of bands and plates became more or less universal for fixation purposes. The disadvantages of these devices, especially the necessity for a second open operation as well as the thought that they did not meet all conditions and also may lead to disturbances in callus formation, together with that human desire to invent something new or different led to the creation of many

types of contraptions which would control the position of the fragments but which could be removed without discomfort to the patient. The number of these bone 'fixation' methods are innumerable. Figures 1 and 2 show a few of the many methods.

#### ABSORBABLE FIXATION MATERIAL

The use of an absorbable material for suture of fractures is theoretically the ideal plan of treatment but practically presents some difficulties which prevent its use.

*Catgut and kangaroo-tendon* In certain simple conditions, the use of a single, simple suture of catgut or kangaroo tendon is of great advantage especially in the replacement of small fragments such as the epicondyles of the humerus. In fractures of the shaft such a suture can be of but very little value as the fixation or retention force is exerted only in that narrow axis represented by the direction of the plane of the suture. The presence of either material does not retard bone repair. The kangaroo tendon may act as an irritant and lead to a sinus formation.

*Beef bone and ivory* That bone would tolerate the presence of ivory and that this substance might in some stimulate the formation of callus was suggested by Diefenbach in 1846. In a case of delayed union, he drilled holes near the ends of the fragments and put in ivory pins which projected through the skin and were later removed. In 1879, Socin and Burchardt drove ivory posts into the fragments of an ununited fracture and had union finally. In 1887 Bernays attempted experimentally to hold a fracture by means of bone plates which he obtained after implanting bone sawdust into the abdominal walls of a dog. In 1913 Magnuson reported his results with the use of ivory plates and screws, stating that ivory was acceptable to human bone tissue that it did not cause softening of surrounding bone, was gradually absorbed and did not become loose since the bone grew in as the ivory is absorbed. In his method he used a key plan in which the ivory plate was set in a slot cut through the cortex so that its plane would be at right angles to the greatest tendency to displacement of the fragments (Fig. 1). In 1914 Brougham published a preliminary report on the use of beef bone plates which were attached to the side of the bone by means of screws. In 1927 Bollarsky suggested the use of cow horn in the manufacture of plates. In the same year Henderson presented his work on the making of beef bone plates and screws which he considers preferable to other types. Bailey, in 1929 reported the use of beef bone

plates in 39 cases and Greenwood instead of screws, used as a modification square pins driven through the cortex. The following year Dahl Iverson described a special plate tied on to the shaft of the bone by strands of an absorbable material.

*Intermedullary pegs* The earliest reference to the use of an ivory intermedullary peg is that of Bircher in 1886, but apparently nothing along this line of fixation was further suggested until in 1912 when Hey Groves (51) advocated the use of such a peg made from beef bone. In 1914 Davison reported that he had used autogenous bone plugs in the medullary canal with success. This type of fixation has had at times supporters especially Hendon and Allen but so many unfortunate results have been reported that perhaps these pegs should be used only as a last resort, although mechanically they are ideal for this purpose. Davison and Christopher as a result of their experimental studies in the use of beef bone intermedullary pegs gave these observations: (1) That part of the boiled beef bone which remains in aseptic stable contact with the endosteum of its host, surrounded by living bone becomes solidly embedded in new bone. The peg undergoes gradual absorption and is replaced by living bone which later in turn, is absorbed. (2) That part of the beef bone which lies between the fragments, but not protected by endosteum and not covered by living bone, even with aseptic surroundings, undergoes rapid absorption and disintegration and is not replaced by new living bone. (3) When one end of the beef bone is not fixed in stable contact with the endosteum but remains in position, there is gradual absorption of both the peg and the surrounding bone. (4) That the internal callus, when the mechanical fixation holds and is aseptic, is limited by the beef bone and does not bridge the line of fracture. The external callus is markedly lessened and the permanent or definitive callus is inhibited. (5) That the series of experiments did not produce a single successful anatomical and functional result. (6) That the causes of failure were (a) infection which was frequent and usually fatal (b) disengagement of the peg due to failure of mechanical reduction or to lack of continued immobilization or to loosening of the repair by absorption of the peg and the surrounding live bone, (c) disintegration of the peg from absorption at the line of fracture. A repair apparently mechanically perfect would show a good result as long as the peg remained strong enough to support the bone. When disintegration of the peg occurred at the line of fracture a point of mobility

would be found. The end result of their experiments were either a permanent non-union or lateral union usually in malposition.

In 1916 Kane suggested the use of a metal scroll which was introduced into the medullary canal wound rather tightly. It was then drawn down across the line of fracture and the retaining strand loosened to allow the scroll to unwind.

*Sliding grafts* Albee and also Buchanan, in 1912 suggested the use of a sliding graft for fixation purposes in fractures which in 1932 was modified by Förster to make the graft fit more snugly. This method has been used perhaps more in delayed and non union cases than in fresh fractures.

*Fascial sutures* The use of fascial sutures has apparently not been adopted to any great extent no doubt due in a large part to the fact that a second incision must be made leading to the possibility of infection and to the scarring of the skin. Patterson (Fig. 2) and Roberts have reported such methods and recently Ober has suggested the use of a part of the quadriceps tendon for the repair of a fracture of the patella.

From the many different methods suggested for holding fractures in position at time of open reduction there has not been any one plan of operation nor any one type of material nor any one device which has been universally adopted by the fracture surgeons. As stated previously there has developed two groups or schools of thought, one in which absorbable material is used and one in which non-absorbable material is used to hold the fragments. The latter group is further subdivided one group using a buried fixation apparatus (short screws and nails, bands, plates) which demand removal through a second operation and one group using devices which transfix the skin and soft tissues (long screws, transfixation pins and bolts, special clamps) to be removed without further operation.

The criticism of all methods for internal fixation of fractures is practically the same for each method and is based either upon the reaction of the body tissues to foreign material or upon the difficulty of the application of the fixation device to the bone. All the methods suggested so far require special material and special instruments, necessitate to a large degree some experience in the technique of application and thus are not open to the average surgeon and further lead to long operations and to a considerable trauma to the tissues. No one method is applicable to all types of fractures and thus the operator must have several different kinds of apparatus and be able to apply them as indicated when the fracture line is

exposed. In the use of the non-absorbable material there are the added disadvantages of a second operation for the removal of the metallic device the danger of unfavorable reaction of the tissues resulting in infection, sinuses, delayed union and non union, and also the frequent breaking of the metal or its loosening from the cortex of the bone.

#### INTRAMEDULLARY SPIKE OPERATION

With the hope of overcoming all of these disadvantages and objections which have been made to the many methods of operation and to the many types of devices for internal fixation of fractures, a simple procedure is herewith offered. It cannot be called a "new" operation for doubtless the principle has been used frequently but only when the conditions found at the time the fracture line was exposed made its application possible. Originally must perhaps be accredited to Roux, who in 1833 "resected a fracture and inserted the tip of one end of a fragment into the medullary cavity of the other fragment" (Bérard) *That the suggested plan of operation can be used as a definite line of attack in all open reductions of fractures may be offered as a new thought*.

In this simplified operative procedure for fixation of fractures requiring an exposure of the fracture line all foreign material is eliminated, no special instruments and special material are required the danger of infection and sinus formation is limited to that of any simple open operation upon a fracture, any type of fracture at any point on the shaft of a long bone even close to a joint (with the exception of one badly comminuted) may be reduced and securely fixed until external splintage is applied, traction apparatus is not required the length of operative time is lessened, the trauma to the tissues is minimized, the skin incision is short and the operation can be performed by the average surgeon in any operating room suitable for bone work. It does not influence the formation of callus and bone healing other than that which occurs in all open fracture work, an added 2 or 3 weeks for solid union. It can be used in compound as well as in simple fractures and in selected early cases of non-union one may expect union without the use of some type of bone graft.

The operation is based upon the simplest of mechanical principles and physical laws (Fig. 3). When the shaft of a long bone is fractured without comminution the fracture line may be smooth and straight but, in practically all instances, one will find that the ends of the fragments are serrated in varying degrees. If a perfect reduction is

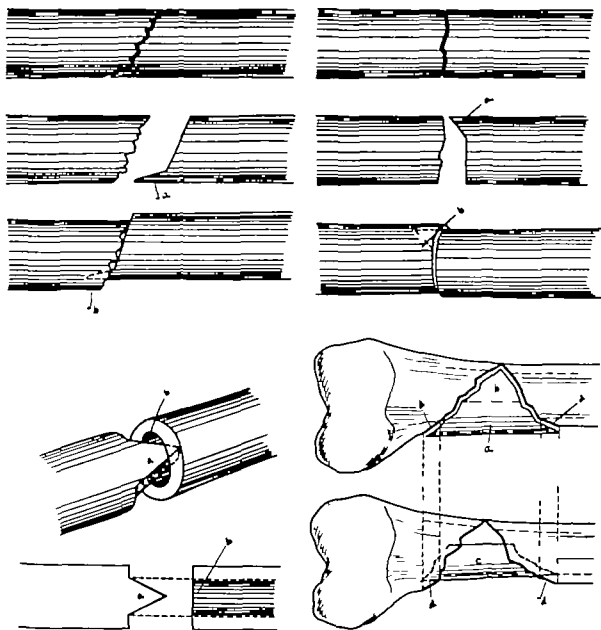


Fig 3 Intramedullary spike operation.

obtained these serrated surfaces will fit and dovetail one into another thus giving a complete restoration of the contour and shape of the bone. Rarely however is the fixation which comes with this perfect reduction of sufficient strength to maintain the position of the fragments against the ordinary handling of the limb or against the normal physiological pull of the muscles and the reduction is lost. It is impossible in such a fracture line further to increase the fixation of the fragments by introducing any of the serrated points on one fragment into the medullary cavity of the other fragment as the bevel of the fractured end will impinge against the bevel of the other end. Nor will impaction of one fragment into the

other fragment be possible on account of the density and solidity of the cortical rim of the bone. Even in comminuted fractures one will find it almost always impossible to impact the fragments or to insert a point of one fragment into the medullary canal of the other on account of the impingement element.

It is, however, possible to form a spike upon one fragment which can be used as an intramedullary fixation by cutting back the bevel of the circumference of the cortex a distance of one-quarter of an inch with the exception of that portion of the cortex which constitutes the base of the spike. It is upon this simple principle that the proposed operation is based. It is applicable

would be found. The end-result of their experiments were either a permanent non union or lateral union usually in malposition.

In 1916 Kane suggested the use of a metal scroll which was introduced into the medullary canal wound rather tightly. It was then drawn down across the line of fracture and the retaining strand loosened to allow the scroll to unwind.

*Sliding grafts* Albee and also Buchanan, in 1912 suggested the use of a sliding graft for fixation purposes in fractures which, in 1932 was modified by Forrester to make the graft fit more snugly. This method has been used perhaps more in delayed and non-union cases than in fresh fractures.

*Fascial sutures* The use of fascial sutures has apparently not been adopted to any great extent no doubt due in a large part to the fact that a second incision must be made leading to the possibility of infection and to the scarring of the skin. Patterson (Fig. 2) and Roberts have reported such methods and recently Ober has suggested the use of a part of the quadriceps tendon for the repair of a fracture of the patella.

From the many different methods suggested for holding fractures in position at time of open reduction there has not been any one plan of operation nor any one type of material nor any one device which has been universally adopted by the fracture surgeons. As stated previously there has developed two groups or schools of thought, one in which absorbable material is used and one in which non-absorbable material is used to hold the fragments. The latter group is further subdivided one group using a buried fixation apparatus (short screws and nails, bands, plates) which demand removal through a second operation and one group using devices which transfix the skin and soft tissues (long screws, transfixation pins and bolts, special clamps) to be removed without further operation.

The criticism of all methods for internal fixation of fractures is practically the same for each method and is based either upon the reaction of the body tissues to foreign material or upon the difficulty of the application of the fixation device to the bone. All the methods suggested so far require special material and special instruments, necessitate to a large degree some experience in the technique of application and thus are not open to the average surgeon and further lead to long operations and to a considerable trauma to the tissues. No one method is applicable to all types of fractures and thus the operator must have several different kinds of apparatus and be able to apply them as indicated when the fracture line is

exposed. In the use of the non-absorbable material there are the added disadvantages of a second operation for the removal of the metallic device, the danger of unfavorable reaction of the tissues resulting in infection, sinuses, delayed union and non-union, and also the frequent breaking of the metal or its loosening from the cortex of the bone.

#### INTRAMEDULLARY SPIKE OPERATION

With the hope of overcoming all of these disadvantages and objections which have been made to the many methods of operation and to the many types of devices for internal fixation of fractures, a simple procedure is herewith offered. It cannot be called a new operation for doubtless the principle has been used frequently but only when the conditions found at the time the fracture line was exposed made its application possible. Originality must perhaps be accredited to Roux, who in 1833 resected a fracture and inserted the tip of one end of a fragment into the medullary cavity of the other fragment" (Bérard) *That the suggested plan of operation can be used as a definite line of attack in all open reductions of fractures may be offered as a new thought*

In this simplified operative procedure for fixation of fractures requiring an exposure of the fracture line all foreign material is eliminated no special instruments and special material are required the danger of infection and sinus formation is limited to that of any simple open operation upon a fracture, any type of fracture at any point on the shaft of a long bone, even close to a joint (with the exception of one badly comminuted) may be reduced and securely fixed until external splintage is applied, traction apparatus is not required the length of operative time is lessened the trauma to the tissues is minimized, the skin incision is short and the operation can be performed by the average surgeon in any operating room suitable for bone work. It does not influence the formation of callus and bone healing other than that which occurs in all open fracture work, an added 2 or 3 weeks for solid union. It can be used in compound as well as in simple fractures and in selected early cases of non-union one may expect union without the use of some type of bone graft.

The operation is based upon the simplest of mechanical principles and physical laws (Fig. 3) When the shaft of a long bone is fractured without comminution, the fracture line may be smooth and straight but, in practically all instances, one will find that the ends of the fragments are separated in varying degrees. If a perfect reduction is

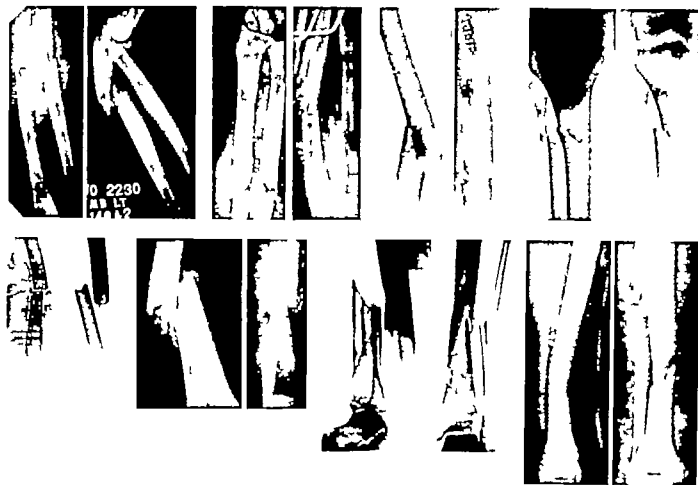


Fig. 4. Roentgenograms of author's cases.

regarded. In the lower extremity a shortening of such a degree is again not a source of impairment or disability and can be easily corrected by a lift on the heel or accommodated by a tilt of the pelvis without causing a scoliosis. In the forearm the writer believes that traction is essential in any form of treatment, be it that of closed reduction or that of open reduction with some type of internal fixation. The muscle strains and pulls which are peculiar to the forearm make this element in treatment a necessity. In the medullary spike operation traction is not applied in adults, for the first 2 weeks. At the end of that time the callus formation is sufficient to prevent displacement of the fragments through the use of that amount of traction needed to prevent angulation. The splint is changed at this time and some type applied which incorporates traction principles.

The control of the angulation in the shaft is not a difficult problem in the humerus or the femur or the tibia. At the end of 10 to 14 days the plaster splint can be so cut at the fracture line as to form a hinge at the apex of the angulation. Under the fluoroscope the distal fragment can be

brought into alignment with the proximal fragment by merely bending or hinging the splint and again fixing it in the desired position by a few turns of a plaster bandage.

The intramedullary spike operation has been the writer's plan of treatment in open reduction for a period of 5 years. There have not occurred any instances of non union nor any complications leading to a disability other than that which would have been expected had a simple reduction been made of the fracture. In several cases of non-union which were seen before a great amount of eboration of the bone had taken place this method was used with success without the added element of any type of bone graft. Figure 4 shows prints from X ray films.

#### CONCLUSIONS

1. Open reduction of fractures of the long bones should be carried out only after earnest and repeated efforts by means of simple closed methods have failed to give a position of the fragments which will lead to satisfactory function.

2 Some type of internal fixation, either of absorbable or non-absorbable material, has been advocated for many years. No one type has been universally accepted.

3 The author's medullary spike operation for fixation has many advantages: (1) Simplicity; it can be performed by any competent surgeon; (2) no special instruments other than a bone rongeur are required; (3) no foreign material is used; (4) the method is applicable to any type of fracture and at any portion of the bone (near joint); (5) a very short incision can be used; (6) there is a minimum amount of trauma to the soft tissues and to the bone; (7) no second operation is necessary; (8) union is delayed not more than in any open reduction; (9) traction is needed only to prevent angulation; (10) the method can be used in compound as well as simple fractures.

## BIBLIOGRAPHY

- 1 ALDER, F. H. *Am J Surg*, 1914, xxviii, 30.
- 2 ALON, E. *Bull et mém. Soc. de chir. de Par*, 1920, xli, 581.
- 3 ALLEN, H. K. *Indianapolis M J*, 1912, xv, 34, 344.
- 4 *Idem*, *J Indiana M Am*, 1920, xlii, 61-62.
- 5 ANOMANDER, S. *M & S J*, 1897, l, 868-870.
- 6 ARNDT, A. P. C. *Ann Surg*, 1905, lxi, 528-53.
- 7 BAILEY, H. *Lancet*, 1920, i, 820-81.
- 8 BARTLETT, W. *Boston M & S J*, 1913, cliviii, 140-156.
- 9 BECKHAM, C. H. *Surg. Gynec. & Obst.*, 1924, xiv, 7-76.
- 10 BELL, W. L. *Ann Surg*, 1909, lxxv, 754-757.
- 11 BÉHARD, Thèse de doct. Paris—Concours, 833.
- 12 BÉHARD, FÉLIX L. *Paris de la Maye*, 1870, xii, 744.
- 13 BERNARD, A. C. *Med. Brief*, 1837, xv, 43-45.
- 14 BERNER, H. *Arch. f. klin. Chir.*, 1880, xxxv, 4-422.
- 15 BORTOLINI, N. M. *Vestnik Khir.*, 1917, ix, 244-245.
- 16 BROWNE, W. M. *Am J Surg*, 1914, xxviii, 6-20.
- 17 BROUGMAN, E. J. *Surg. Gynec. & Obst.*, 1914, xviii, 637-640.
- 18 BROWMAN, J. J. *Internat. J. Surg.*, 1914, xiv, 300-31.
- 19 CARRILL, W. B. *J. Am. M. Ass.*, 1913, xcvi, 670-673.
- 20 CARRILL, A. W. *J. Am. M. Ass.*, 1920, lxxv, 950-951.
- 21 *Idem*, *Arch. Surg.*, 1921, li, 354-366.
- 22 COVEY, H. R. *J. Bone & Joint Surg.*, 1917, xii, 261-268.
- 23 COCULLEN, A. C. *Bol. y trab. Soc. de ciruj. de Buenos Aires*, 1923, xii, 600-617.
- 24 CROCO and ROLLAND, Thèse de doct. Paris, 1920.
- 25 DALL'IGNAZIO, E. *Arch. f. klin. Chir.*, 1920, cxviii, 680-684.
- 26 DAYTON, CHARLES. *Surg. Gynec. & Obst.*, 1914, xiv, 750-753.
- 27 DAVISON and CHRISTOPHER. *Surg. Gynec. & Obst.*, 1924, lxxviii, 534.
- 28 DREIFUSS, W. *Wchnsch. f. d. ges. Heilk.*, 1846, 729, 745, 76.
- 29 DUBAY, K. H. *China M. J.*, 1927, xli, 3-6-324.
- 30 DUJARIER, CH. and JACOT. *Bull et mém. Soc. anat. de Par*, 1901, lxxvi, 65-652.
- 31 DUJARIER. *Bull. et mém. Soc. de chir. de Par*, 1920, xli, 902.
- 32 ELIASSON, E. L. *Internat. Clin*, 1924, xxiv, S. 4, 221-225.
- 33 ESTER, W. L. *Lehigh Valley M. Mag.*, 1896, vi, 210-228.
- 34 *Idem*, *Ann. Surg.*, 1920, xxi, 583-588.
- 35 FOLSTER, W. *Zentralbl. f. Chir.*, 1921, lxx, 335-339.
- 36 FRANK, J. *Surg., Gynec. & Obst.*, 1915, xlii, 783-785.
- 37 FREDT, Bull. et mém. Soc. de chir. de Par, 1920, xli, 902.
- 38 FREEMAN, L. *J. Am. M. Ass.*, 1913, lxi, 930-931.
- 39 *Idem*, *Surg. Gynec. & Obst.*, 1922, July.
- 40 GAILLARD, E. S. *New York M. J.*, 1865, ii, 116-120.
- 41 GOODEMAN, M. J. *Scalpel*, 1932, lxxv, 49-55.
- 42 GRANT, H. H. *Tr. South Surg. Ass.*, 1906, xix, 97.
- 43 GREENWOOD, H. H. *Lancet*, 1920, ii, 21-22.
- 44 HALLOPEAU. *Bull. et mém. Soc. de chir. de Par*, 1920, xli, 879.
- 45 HARRISON, A. H. *Ann. Surg.*, 1910, lxxx, 16-170.
- 46 HARTLEY, G. W. *Internat. M. J.*, 1906, xii, 277-281.
- 47 HEARD, J. S. *New York J. M. & S.*, 1899, li, 343-358.
- 48 HENDERSON, M. *Illinois M. J.*, 1927, li, 3-34.
- 49 HENDERSON, G. A. *Kentucky M. J.*, 1928, xxxi, 265-269.
- 50 HENRIET. *Surg. Gynec. & Obst.*, 1911, xiii, 80.
- 51 HET GROVER, E. W. *Brit. M. J.*, 1912, ii, 1-2-105.
- 52 *Idem*, *Brit. M. J.*, 1913, i, 4-43.
- 53 *Idem*, *Brit. J. Surg.*, 1913, i, 4-43.
- 54 *Idem*, *Lancet*, 1914, i, 5-13.
- 55 *Idem*, *Lancet*, 1920, i, 1040-1054.
- 56 HOGAN, BART. *Lancet*, 1920, li, 505-507.
- 57 ICART, J. de méd. Chir. et Phar. de Roux, 775 xlii, 170.
- 58 JOVANA, E. *Bull. et mém. Soc. de chir. de Par*, 1923, xii, 618-633.
- 59 KANE, E. O. *Internat. J. Surg.*, 1916, xiii, 33-35.
- 60 KENTLEY, C. B. *Tr. M. Soc. Lond.*, 1897-1903, xvi, 181-88.
- 61 KRICHEVSKOY, H. J. *New York State J. Med.*, 1931, xlii, 438-440.
- 62 LAKE, W. A. *Surg. Gynec. & Obst.*, 1900, April.
- 63 *Idem*, *Lancet*, 1905, June 12.
- 64 *Idem*, *Lancet*, 1911, November 4.
- 65 *Idem*, *Lancet*, 1923, xi, 800.
- 66 *Idem*, *Operative Surgery*, London: Medical Publishing Co., 1914.
- 67 LAMBOTTE, A. *J. de chir. et ann. Soc. belge de chir.*, 1902, x, 1-2-17.
- 68 LATHROP, W. *Ann. Surg.*, 1906, lxxxv, 68-73.
- 69 LATHROP, F. *Am. J. M. Sc.*, 1870, lxxvii, 434-436.
- 70 LATHROP and FOUCAUD. *Bull. et mém. Soc. de chir. de Par*, 1918, xli, 1145.
- 71 *Idem*, *Bull. Soc. de chir. de Par*, 1920, July 2.
- 72 LEVIER, A. *Am. J. M. Sc.*, 1890.
- 73 LEXER. *Deutsche Zeitsch. f. Chir.*, 1905, cxviii, 70.
- 74 LUND, F. B. T. *Am. Surg. Ass.*, 1906, xxxv, 427-433.
- 75 MACLEAN, H. S. *Tr. South. Surg. & Gynec. Ass.*, 1914, xlvii, 100-109.
- 76 MASON, W. H. *Minnesota Med.*, 1921, v, 431-435.
- 77 MATHURON, P. B. *J. Am. M. Ass.*, 1913, lxi, 514-516.
- 78 MASON, A. T. *J. Am. M. Ass.*, 1906, lxxvii, 128.
- 79 MARTIN. *Internat. Clin*, 1924, xxiv, 251-258.
- 80 MULLER. Thèse de doct. Lyon, 1919.
- 81 MORRISON, R. *Ann. Surg.*, 1909, li, 1124-1127.
- 82 OBER, F. *J. Bone & Joint Surg.*, 1912, xiv, 640.
- 83 PANCOAST. *Operative Surgery*, Philadelphia: Carey, 1844.
- 84 PARKMAN, F. W. *New Orleans M. & S. J.*, 1912-1914, xii, 451-452.

85. Idem. *Surg. Gynec. & Obst.*, 1916, *xxiii*, 541.
86. PARKHILL, C. *Tr. Am. Surg. Ass.*, 1897, *xv*, 251-256.
87. PATTERSON R. H. *Ann. Surg.*, 1928, *lxxviii*, 879-884.
88. PIERCE H. C. *J. Bone & Joint Surg.*, 1913, *xiii*, 589.
89. PUTZ, Chir. *chir.* 1914, *xxii*, 1021-1024.
90. ROBERTS, JOHN B. *Ann. Surg.*, 1916, *lxiii*, 182-184.
91. SCUDDER, C. L. Philadelphia: W. B. Saunders, 1926.
92. SCUTLER, H. S. *Ann. Surg.*, 1913, *lviii*, 653-655.
93. SEOW NICHOLAS. *Tr. Am. Surg. Ass.* 1893, *ii*, 1-40.
94. SHERMAN, WILLIAM O'N. *Surg. Gynec. & Obst.* 1912, *xiv*, 629-634.
95. SMITH J. F. *Surg., Gynec. & Obst.* 1920, *xxx*, 319.
96. SONNENSCHEIN H. D. *J. Am. M. Ass.* 1927, *lxxxviii*, 243.
97. STANLEY, E. G., and GATHELLER, J. *Brit. J. Surg.* 1921, *ix*, 259-271.
98. STIMMON LEWIS. *Treatise on Fractures*. Philadelphia: Lea & Sons, 1883.
99. STRAUSS, D. *Surg. Gynec. & Obst.* 1914, *xix*, 410.
100. STREINACH, L. W. *Med. Rec.* 1900, *lvii*, 602.
101. TERNANT C. E. *J. Am. M. Ass.* 1924, *lxxxiii*, 193.
102. THIÉRIAR, J. *Ann. Soc. belge de chir.* 1894-1895, *ii*, 44-51.
103. THOMPSON J. E. *M. Surg., Gynec. & Obst.* 1924, *xxxix*, 356-359.
104. TROJAN E. *Zentralbl. f. Chir.*, 1927, *liv*, 2628-2630.
105. VELPEAU ALF. *Nouveaux Elements de Medecine Operatoire*. Paris, 1839.
106. VON HEINE, C. *Arch. f. klin. Chir.* 1878, *xxii*, 472-495.
107. YOUNG, A. *Brit. M. J.* 1922, *ii*, 1209-1214.
108. ZIEROLD A. A. *Arch. Surg.*, 1924, *lx*, 364.



## THE FLAP OPERATION FOR THE TREATMENT OF ACUTE EMPYEMA THORACIS<sup>1</sup>

ALEXANDER NICOLL, M.D. F.A.C.S. NEW YORK

Surgical Director of the First Surgical Division, Fordham Hospital, Staff Surgeon, St. Elizabeth Hospital

THE operation described below has given us such good results that it merits description.

Like many excellent things its origin with us was due to accident: an intended open drainage of the chest was done in such a way that the incision was not quite straight and the rib which was resected was not immediately beneath the skin incision but a space above it. This resulted in a rudimentary flap which acted for 24 hours as a valve at the expiration of which time nature corrected the mistake and open drainage was secured. The idea was seized upon, however, and through many stages of experimentation and development the present flap operation was perfected by the writer. The work done with this beginning started in 1915 and the operation as at present done was more or less standardized in 1917. Since that time minor modifications have been made from time to time but the essential features have not been materially altered. Work by myself and associates during the War and since has convinced us that the operation has unusual merits.

A brief résumé of the last 35 consecutive cases is appended. It will be noted that 17 cases were in children, the ages varying from 4 months to 14 years of age. One child 2 years old, died the rest recovered promptly and completely. In the 18 adult cases there were 3 deaths. In one patient (Case 22) it was felt that the pleural condition was but a part of a generalized and overwhelming infection, and operation did not influence for better or worse the course of the disease. In Case 26 patient came to the operating table with a massive concealed gastro-intestinal hemorrhage which became manifest immediately after operation in spite of a completely satisfactory pleural response to operation the patient died 5 days after operation of uncontrollable gastro-intestinal hemorrhage. In 5 cases the acute empyema complicated definite lung abscess all made good recoveries with complete healing of the pleural lesion (Cases 7, 14, 17, 21 and 23). All patients were operated on as soon as seen in consultation, which was usually immediately after the diagnosis was established, without regard to the organism present or the condition of the pleural exudate the criterion of "thick or thin pus" was discarded for the older—and

better—surgical principle—*ubi pus, ibi crescit*. Pre-operative paracentesis was diagnostic only—as soon as it was felt that the patient's condition justified any mechanical interference, the flap operation was done. Case 23 was an exception to the dictum of immediate operation he was seen after a protracted siege of several months of lung abscess, and he appeared to be so altogether fragile emaciated and exhausted by prolonged sepsis that any operative procedure must be followed promptly by death. He was seen daily for one week during which time every effort was made to make him operable at the end of this week he appeared worse if possible and with the feeling that there was nothing to lose he was operated on, made prompt improvement, and went on to eventual recovery from his acute empyema. This man had three distinct probably intercommunicating abscesses the entire pulmonary picture had a background of tuberculosis which has since been definitely established.

Treatment is carried out along the following lines:

**Diagnosis.** Diagnosis is established by the usual methods of clinical examination with due emphasis upon the use of the X ray.

**Position of the patient.** The patient is placed upon the operating table and turned partly upon the sound side the arm on the affected side is abducted, the hand resting palm down upon the table beside the face.

**Anesthesia.** The anesthesia for the adult is novocain in 1 per cent and 2 per cent solution. The children are given either open drop, after preliminary morphine and atropine in suitable dosage.

**Selection of the site of rib resection.** The rib to be resected is chosen by careful clinical and X ray examination the most dependent portion of the cavity with the patient in the sitting position at its posterior or mesial border is mechanically the ideal spot for drainage actually and practically the opening into the chest is not possible at this point, nor is it necessary as experience has shown. Except in the unusual case the rib to be resected is the eighth and the spot at which resection is made is in the region between the posterior axillary line and the line of the angle of the scapula with the arm at the side. It is not wise,

<sup>1</sup>Read before the W. Waterbury Medical Association, Waterbury, Connecticut.

as a rule to go lower than the eighth rib certainly not lower than the ninth because of interference with drainage by the rising diaphragm. If a rib higher than the eighth is resected the relation of the opening to the scapula in all its positions must be considered or drainage may be blocked by this bone.

*The Flap.* The point at which the rib is to be resected is taken as the center of the base of the flap and anesthesia in the adult is induced by local infiltration and field block with novocain solution 1 per cent. The production of four wheals along the proposed lines of vertical incision and three wheals on the lower connecting horizontal incision aids in the distribution of the local anesthetic. The incision is L shaped with rather sharp angles. It begins 2 inches mesial to the center of the base of the flap, is carried vertically downward for a distance of 4 inches, turns abruptly laterally and is carried horizontally for a distance of 4 inches, then turns abruptly upward and is continued vertically to end at the level of the center of the base of the flap and 2 inches laterally from that point. This outlines a flap 4 inches across at the base, 4 inches across at the apex and with parallel vertical sides 4 inches long (Fig. 1). The incision is carried through the subcutaneous fat to the fascial plane of the back. The entire skin flap with its attached subcutaneous fat is now elevated to a point a little above the site of the intended rib resection (Fig. 2). The portion of the rib to be resected is chosen carefully with regard to its position in the exact center of the base of the flap because of the elevated and abducted position of the arm on the affected side. It is wise to choose a point a little mesial to the apparent center. Occasional-ly the latissimus dorsi will interpose some fibers at this point and if this is so the interfering portion of the muscle is blocked with novocain and resected between clamps (Figs. 2 and 3). The portion of the rib to be removed is exposed and the subperiosteal tissue is infiltrated with 2 per cent novocain solution for a distance of 2 inches. One inch of rib is resected subperiosteally (Fig. 3). We found that in the adult and conscious patient a simple expedient spares the patient the shock of the sound of rib resection with the costatome in position he is encouraged to chew a few lumps of ice and while he crunches, so does the surgeon. This little trick serves as a really valuable psychic adjunct to local anesthesia. The mastoid is now attended to. The parietal pleura is injected with 2 per cent novocain solution and is incised for a distance of three fourths of an inch as the pleura is incised the index finger is immediately

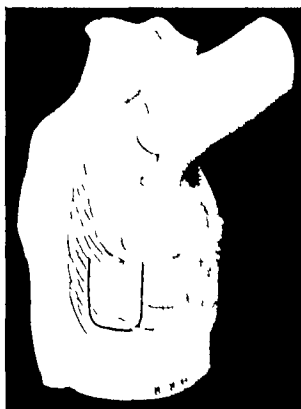


Fig. 1. Showing outline of flap and its relation to resection of rib.

introduced, thus plugging the opening and preventing both the emptying of the chest and the ingress of air to the pleural cavity. An empyema button prepared by attaching to the lower half of its outer flange a piece of rubber dam  $1\frac{1}{2}$  inches wide split up to within 1 inch of the flange and through which a strong, removal string, of braided silk is threaded (Fig. 4) is introduced during expiration (Fig. 5) and the entire flap immediately replaced and pressure made by the finger of an assistant upon the skin overlying the canal of the button preventing or impeding the escape of pus. The wound is now closed with a single suture at the midpoint of the horizontal arm on each side of which the fish tailed rubber dam is brought out the removal string also emerging beside this suture. The vertical incisions are closed carefully and accurately with a suitable number of Michel clips, one or two clips also being placed in the lateral extremities of the horizontal wound (Fig. 6).

*Immediate postoperative care and operative dressing.* If it is considered wise to allow the chest to empty immediately the finger pressure on the flap is removed and the flap functions with expiration or coughing pus is seen to pour out along the rubber dam escaping from the unsutured horizontal wound with inspiration the

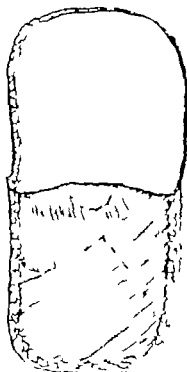


Fig. 2. Flap elevated showing underlying structures and indicating the occasional necessity for reflecting the fibers of the latissimus dorsi.

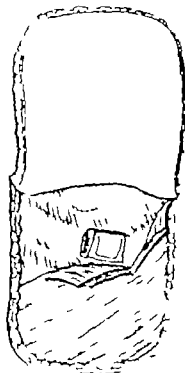


Fig. 3. Latissimus dorsi resected, and portion of rib removed subperiosteally. Pleural incision indicated as a "trap-door." Our present incision is a straight line.

flap instantly plugs the opening in the button and prevents the ingress of air to the chest and the expansion of the lung is initiated with the taking of the first breath. The simple mechanics of this procedure are illustrated in Figure 7. If the condition of the patient is such that the surgeon feels that a less rapid emptying of the chest is wise a gauze pad is substituted for the finger pressure of the assistant and this pad is held in place by an adhesive strap applied after the dressing of the vertical incisions. This strap can be released from time to time in the first 24 hours after operation, and discarded at the expiration of this period. For the dressing of the vertical incisions a simple form of prepared dressing is convenient this may be made by padding with gauze a horseshoe-shaped form of cardboard or other suitable firm material of correct dimensions. This is applied with the points downward extending just below the level of the horizontal incision and with the rounded portion of the horseshoe well above the level of the pleural opening. The

horizontal portion of the incision is left undressed except for fluff-gauze to catch discharge no pressure upon this portion of the incision being permitted.

*Subsequent postoperative care.* The postoperative care consists of replacing the soiled fluff-gauze dressing with fresh gauze as indicated. The patient is out of bed usually within 24 hours. When X ray examination indicates the complete expansion of the lung the button is removed by traction upon the removal string. The suture and clips are removed not earlier than the eighth day and after removal of the clips the vertical incisions are strapped the granulating areas at the horizontal arm are treated by appropriate applications.

It is our present feeling that we have been overthrid in removing the button and that our present average of 9 days is much too long. The cases complicated by bronchial fistula, as indicated by varying grades of pneumothorax require that the pleural negative pressure drainage be con-

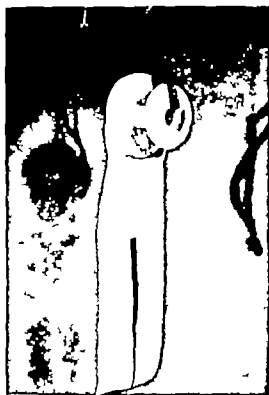


Fig. 4. "Home-made" modification of Wilson empyema button showing stout "removal string" and apron of rubber dam sewed to outer flange of button.

continued until healing of the pulmonary fistula has occurred and no time limit can be set. In this group of cases it will be wise to permit the button to remain in place until the pneumothorax has disappeared, or until such time as the surgeon feels that the parietal pleural wound has been sufficiently established to maintain pleural negative pressure until the expansion of the lung has been completed. Lung gymnastics may be indulged in.

The operation described during its development, has been modified in many ways. In all cases generous flaps and rib resections have been made the dimensions of the flap as given—four inches by four inches—are suited to the average slender male patient. In the stout patient, and the muscular the size of the flap should be increased and in children it may be a little smaller but not much. It is fatal to the success of the valve action of the flap to err on the small side. Some patients have had no button some patients have had the unmodified Wilson button some have had tubes of varying lengths the outer ends of which have been sutured beneath the flap some have had rubber dam sutured beneath or to the flap some have had sutures instead of clips.

In the form described this operation is offered as the best form of treatment of acute empyema

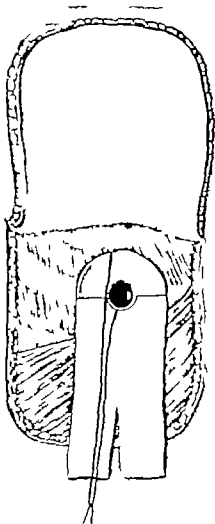


Fig. 5. Button in place.

with which the writer is familiar, for the following reasons

1. It is *physiological* in that it takes into consideration the normal condition of negative pressure within the pleural cavity and *respects* it.

2. It is a *closed* method of drainage and *remains* so from beginning to end of treatment.

3. It affords *adequate* drainage because of the generous opening into the pleural cavity made possible by rib resection with the further *reaming* action of drainage apparatus of our choice.

4. It permits *early operation* in empyema before adhesions in abnormal positions of the lung have occurred without the dangers resulting from "mediastinal flutter" and *collapse* of compressed lung.

5. It can be done under local anaesthesia in adults our youngest local anaesthesia patient was 13.

6. Because it is completely a closed drainage it can be done safely in children under ether anaesthesia.

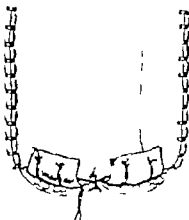


Fig. 6. Flap replaced showing single median suture in lower portion of flap, with vertical incisions closed with Michel clips, and fish-tailed rubber dam drain emerging from unsutured lower portion of flap together with removal string.

7. It abruptly cuts short the sepsis due to undrained or incompletely drained, pus, thus relieving the organs of excretion of their overheavy burden.

8. It shortens convalescence. One of our cases was entirely healed in 10 days, in spite of a chest which held the maximum of pus at operation (Case 33).

The following brief case résumés are submitted. They include the last 35 consecutive cases operated on at the First Surgical Division at Fordham Hospital and in private practice. All patients were operated on by the writer with two exceptions noted below.

CASE 1. F. female 42 years of age. Operation for intestinal obstruction 4 days later operation for acute inflammation of the gall bladder cholecystectomy. Convalescence from second laparotomy complicated by pneumonia. Twelve days after second laparotomy empyema developed. Flap operation was done on the fourteenth postoperative day. Ninth rib was resected, no button used. Recovery was uneventful. Cured.

CASE 2. C. N. male, aged 9 years, had pneumonia. On the eighteenth day empyema was diagnosed. Flap operation was done on nineteenth day. Ninth rib was resected, no button used. Recovery was uneventful.

CASE 3. C. L. male, aged 11 years, was admitted to hospital, with empyema. Immediately flap operation was done eighth rib was resected. Patient discharged 11 days after operation. He returned 6 weeks later with abscess beneath flap. Flap was loosened thus allowing pus to escape. Subsequent recovery was uneventful.

CASE 4. R. C. female, aged 2 years. Diagnosis pneumonia and empyema. Flap operation was done day following admission to hospital. General anesthesia was used, ninth rib was resected, no button was used. There was a profuse discharge of pus. Sepsis was unchecked and patient died 5 days after operation.

CASE 5. C. B. male, aged 11, was admitted to hospital with diagnosis of empyema. Flap operation was done under general anesthesia. Ninth rib was resected, no button. A large quantity of pus was evacuated. Temperature became normal following operation. Recovery was uneventful.

CASE 6. Q. M. male child, was suffering with empyema. Immediate operation was done, the ninth rib being resected. No button was used. Convalescence was good.

CASE 7. C. W. male, aged 30, was admitted to the hospital with empyema. Flap operation was done immediately. Patient coughed up about 2 quarts of thick yellow pus. He left hospital 14 days later improved but running a temperature of 100 degrees.

CASE 8. G. J. male, aged 14, was operated upon on admission to the hospital for ruptured gangrenous appendix with general peritonitis. Twenty six days later he had left lower lobe pneumonia. One month later a flap operation was done, the ninth rib was resected. No button was used. Twenty five days later temperature was normal, the wound was clean, and patient was discharged. The infecting organism was the streptococcus.

CASE 9. P. M. male, aged 30, was admitted to the hospital with history of 3 months of cough. Two days later paracentesis gave pus from which no organism grew. Flap operation was done under local anesthesia. The ninth rib was resected. No button used. A rubber dam was sutured to the under surface of the flap. There was profuse and continuous discharge after operation. There were intermittent rises in temperature. Patient was discharged cured.

CASE 10. M. J. male, aged 9, was admitted to the hospital, with empyema. Pus culture showed staphylococci and diplococci. Immediate flap operation was done with ether anesthesia. The ninth rib was resected. A quart of pus was evacuated at operation. Rubber dam drain placed under flap. Patient made good recovery.

CASE 11. K. H. female, aged 30 years, was admitted to the hospital with empyema. Culture of the pus showed streptococcus mucosus capsulatus. Immediate flap operation was done under general anesthesia. The tenth rib was resected. A rubber dam was sutured to the under surface of the flap, no button. Chest drainage stopped at end of second week, temperature rose and patient had violent attack of coughing followed by profuse discharge. Chest was cleared by X ray and sputum was negative for Bacillus tuberculosis.

CASE 12. C. C. S. male, aged 19, was admitted to hospital, with pneumonia. Three weeks later he had acute abdominal symptoms. Laparotomy showed ruptured appendix with peritonitis. Three weeks later empyema was demonstrated. A flap operation was done on the right side. The ninth rib was resected. Seventeen days later empyema was found on the left side. A flap operation was done and the tenth rib was resected. Culture from both sides showed pneumococci and staphylococci. Patient developed postoperative pyrexia. He was discharged improved. Personal communication reported "cured."

CASE 13. A. R. male, aged 30 years, was admitted to the hospital with symptoms of abdominal pain only 9 days later empyema diagnosis was established. Flap operation with resection of ninth rib was done. Button was inserted. The flap was lined with rubber dam. Patient made good recovery.

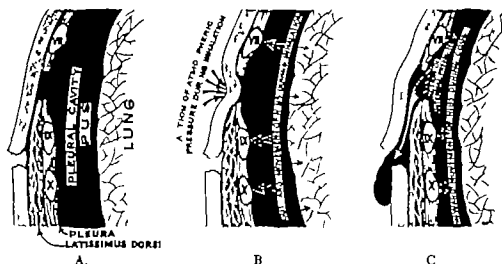


Fig. 7. The mechanics of the flap. A, Static. B During inhalation. C During exhalation.

CASE 14. J. G., male, aged 30 years, was admitted to the hospital with dislocation of hip. He had postoperative pneumonia, with lung abscess and a complicating empyema. Flap operation with resection of ninth rib was done. No button was used. He coughed up 1 quart of foul smelling pus. Culture showed staphylococci. He made a good recovery.

CASE 15. A. V., male, aged 3 years, was admitted to the hospital, with empyema. Flap operation was done and ninth rib resected. No button. Premature adhesion of flap required loosening. Patient made good recovery (Figs. 14 and 15).

CASE 16. M. W. female, aged 22 years, was admitted to hospital in labor. Pneumonia developed 4 days later protracted sepsis. Six weeks after delivery empyema was discovered. Flap operation with resection of eleventh rib was done. Pus was inaccessible so tenth rib was resected. Localized empyema was reached and drained with a tube sutured beneath the flap. Patient made good recovery. Culture showed gram positive diplococci. Local anesthesia was used.

CASE 17. M. R. female, aged 53 years, had pneumonia followed by signs of fluid in chest. Chest tap gave serofibrinous fluid of negative culture. X ray showed lung abscess. Surgical consultation was sought 2 months after admission. A flap operation was done under local anesthesia and ninth rib was resected. Thick, foul smelling pus was obtained. Convalescence was complicated by premature adhesion of flap which was loosened. Patient made good recovery. Cultures always were negative tuberculous? (Figs. 10 and 11).

CASE 18. E. S., female, aged 1½ years, was admitted to hospital with empyema. Flap operation was done under ether anesthesia. The ninth rib was resected. A very thick pleura was found with yeasty smelling pus. No button. Three days after operation X ray examination showed a collapsed lung. Ten days later the X ray revealed an expanding lung. Good recovery followed.

CASE 19. P. S., female, aged 5 had pneumonia. On thirteenth day a diagnosis of empyema was made. A chest tap gave greenish pus staphylococci. Flap operation was done under ether anesthesia. The ninth rib was resected, button inserted. Button was removed on ninth day. Good recovery.

CASE 20. F. S. male, aged 56 years, had pneumonia. Diagnosis of empyema was made on twelfth day. Chest

tap gave thin greenish pus showing cocci staining characteristics not being described. A flap operation was done under local anesthesia. The ninth rib was resected. A button was inserted and removed on seventh day. Premature adhesion of flap occurred. The flap was loosened and patient made a good recovery (Figs. 12 and 13).

CASE 21. E. F., male, aged 45 had pneumonia 1 month previously. He suffered from pain, cough and foul expectoration for 2 weeks. X ray examination showed lung abscess of right upper lobe secondary empyema. Chest tap gave streptococci in pus. Flap operation was done under local anesthesia. The ninth rib was resected. Twelve ounces of fetid pus was evacuated. Convalescence was complicated by premature adhesion of the flap. The flap was loosened and patient made a good recovery from empyema. The lung abscess persisted.

CASE 22. A. P. male, aged 42. Patient was received from Medical service with diagnosis of postpneumonic empyema overwhelming infection other evidences of pyemia. Chest tap gave thin foul smelling pus. Culture showed a Gram negative bacillus and Bacillus Subtilis. Flap operation was done, the ninth rib being resected and a button inserted. Pus became thick and creamy on second day after operation. Sepsis unchanged. Patient died 30 days after operation.

CASE 23. H. S. male, aged 52 had suffered for 3 months with chest symptoms of lung abscess, profound sepsis, and emaciation. X ray examination showed three fluid levels in the lung, definite abscesses. There was a secondary infection of the pleura with thick greenish pus. Flap operation was done and eighth rib was resected. The pleura was thick and adherent to the necrotic lung. There was no odor to the pus which was chocolate colored. Button was inserted and removed on twelfth day. Good recovery followed operation with healing of pleural lesion. Subsequent examinations indicate background of tuberculosis.

CASE 24. M. G. male, aged 6½ years. Twenty days before operation patient had measles. 8 days later pneumonia. Chest tap gave thick, foul smelling pus which showed pneumococci on culture. A flap operation was done and the eighth rib resected. Button was inserted and removed on fourteenth day. Convalescence was complicated by diptheria. Patient made good recovery.

CASE 25. M. M. male, aged 7 had a right sided pneumonia 1 month before operation. Chest tap previous to operation gave thick greenish pus. The flap operation was



Fig. 8. Case 20 immediately before operation was performed.

done by Dr. Harry J. Handelman. Ether anesthesia was used. The eighth rib was resected. A button was inserted. Recovery progressed for 23 days then patient had left sided pneumonia. The end-result was good.

CASE 26. B. F. male, aged 52, had pneumonia followed by empyema on fifteenth day. Chest tap gave foul smelling pus which showed cultured staphylococci when cultured. Thorp operation was done by Dr. Harry J. Handelman,



Fig. 9. Case 20, 3 days after operation, showing lung expansion.

the eighth rib was resected and a button inserted. Patient came to table with concealed massive gastro-intestinal hemorrhage. This became manifest immediately after operation and continued unchecked. Death was due to uncontrollable gastro-intestinal hemorrhage. The pleural condition responded correctly to operation.

CASE 27. J. L., male, aged 35, had empyema following pneumonia. The condition was discovered 46 days after



Fig. 10. Case 17 immediately before operation was performed.



Fig. 11. Case 17 6 days after operation, showing lung expansion.

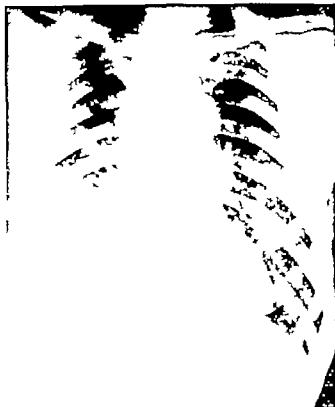


Fig. 12 Case 20 immediately before operation was performed.



Fig. 13 Case 20, 4 days after operation, showing lung expansion.



Fig. 14 Case 15 immediately before operation was performed.

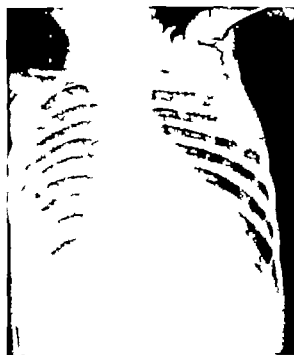


Fig. 15 Case 15 48 hours after operation, showing lung expansion.



the onset of the pneumonia. Chest tap gave thick pus culturing streptococci and staphylococci. Flap operation was done under local anesthesia. The ninth rib was resected, a button inserted. Recovery was good.

CASE 28 F. T. male, aged 6. Two years previously patient had pneumonia followed by empyema. Open operation was done then. Patient was admitted to hospital with pneumonia on same side. Twenty-nine days later chest tap gave pus which showed staphylococci on culture. Flap operation was carried out. Pus was found escaping from the pleural cavity between the ribs at site of drainage of previous operation. A button was inserted at this point between the eighth and ninth ribs. No rib was resected. Patient made good recovery.

CASE 29 A. S., male aged 6, had empyema following pneumonia on eleventh day. Chest tap showed pneumococci. Flap operation was done and eighth rib resected. Button was inserted. The button was removed on sixteenth day. Good recovery followed operation. (Figures 8 and 9.)

CASE 30 E. F. female, aged 13 had empyema following pneumonia. Diagnosis made twenty first day. Chest tap showed pneumococci on culture. Flap operation was done. Good but slow recovery followed, complicated by the necessity for removing inner flange of button which remained behind when removal string broke.

CASE 31 J. R. male aged 64, had empyema complicating pneumonia, on eleventh day. Chest tap revealed pus showing pneumococci on culture. Flap operation was done under local anesthesia. The eighth rib was resected and a button inserted. The button was removed on thirteenth day. Good recovery followed.

CASE 32 E. M., female, aged 5, had measles 6 weeks previous to operation complicated by acute otitis media. Six weeks later empyema was discovered. Chest tap gave culture of pneumococci. Flap operation was done under ether anesthesia and eighth rib was resected and button inserted. The button was removed on seventh day. Good recovery followed.

CASE 33 H., aged 50, had empyema which was discovered 1 month after pneumonia. Flap operation was done. The chest contained maximum of pus. Button was inserted after resection of eighth rib. The button was removed on sixth day. The wound was entirely healed on the tenth day.

CASE 34 E. R. female, aged 4 months, empyema following pneumonia. Flap operation and resection of eighth rib was done. Button was inserted. Patient made a good recovery. Consolidation was delayed because of complete failure of union of vertebrae. Flap functioned perfectly however. Closed drainage persisted throughout, and inspection of the area of rib resection on the fifth day by elevation of the flap, showed that the pleural lesion was then healed.

CASE 35 W. S., male aged 23, had postpneumonic empyema. Culture showed streptococci. Flap operation and resection of eighth rib was done. No button was used. Recovery was good although delayed by tendency to premature healing of the flap.

CASE 36 Mrs. McG. female, aged 30, had empyema complicating pneumonia occurring during puerperium. Flap operation and resection of eighth rib with no button resulted in good recovery.

## PRIMARY CARCINOMA OF THE URETER

W W SCOTT M.D. F.A.C.S. ROCHESTER, NEW YORK

From The Department of Surgery Division of Urology University of Rochester School of Medicine and Dentistry

A REVIEW of the literature on that relatively rare disease, primary carcinoma of the ureter seemed to indicate that in addition to presenting 2 cases of this character an attempt should be made to determine in so far as possible the end results in all acceptable cases reported heretofore, with the hope that further information might be obtained concerning early diagnosis, proper treatment, and prognosis. By means of correspondence with each writer on this subject, or the clinic from which the case was reported, an effort was made to learn the present status of each case that was reported well following operation. The writer is indeed most grateful to all those who obtained and forwarded further information concerning their cases.

Due to the tendency toward more frequent and careful necropsies and the marked progress in the technique of urological diagnosis, primary carcinoma of the ureter has been found with ever increasing frequency during recent years. Wising and Blix reported the first case in 1876. In 1896 Hektoen, in reporting his case referred to 2 others in the literature. The first correct pre-operative diagnosis was reported by Albarran in 1902, and at this time he was able to find 10 acceptable cases in the literature. Richter in 1909 found only 11 cases. In 1916 Schmitt reported 20 cases, and in 1922 Meeker and McCarthy found 33 cases of primary carcinoma of the ureter. Kretschmer in 1929 reported 36 cases including his own. Six years later Rousselot and Lamen were able to find 50 cases including their own. The writer in a review of the literature finds 59 cases of primary carcinoma of the ureter, and in addition presents 2 more.

Because a study of the literature on this subject at once indicates that there is a considerable difference of opinion as to just what constitutes a true case of primary carcinoma of the ureter it seems advisable to state briefly the conditions met by all cases included in this report. In the first place the gross and microscopic descriptions of the tumor had to justify the diagnosis of carcinoma. Next it was necessary to make certain that there was no possibility of the growth's being secondary to a primary tumor located elsewhere in the genito-urinary tract. Lastly it was necessary to prove that the ureteral growth could not be due to a metastasis or direct extension from some

point outside the genito-urinary tract. It is our belief that the 2 cases to be presented meet these requirements.

CASE 1 C.D., S.M.H., No. 40064, aged 55 years. October 24, 1930. Patient complained of pain in the right side of back. Fourteen months before admission to the hospital the patient noticed a sudden attack of pain in the right kidney region and radiating slightly anteriorly. Morphine was necessary for relief. One month later he had a similar attack, which was accompanied by hematuria. He consulted a urologist, who encountered an obstruction of the right ureter which he was unable to pass. An operation was advised but refused. At intervals of a month or two he had recurrent attacks of dull pain in the right kidney region and hematuria. The blood in the urine never appeared in the form of worm-shaped clots, but was evenly distributed in all three specimen glasses. There was no history of calculi. The patient had lost 20 pounds in weight during the last year and did not feel so strong as formerly. The family history was unimportant. The past history revealed nothing essential.

The patient was evidently a little anemic and showed signs of recent loss of weight. The heart was moderately enlarged and the heart sounds were faint. The blood pressure was 130-90. The right kidney was palpable and its surface was smooth. There was a little tenderness in the right upper quadrant. The prostate gland was slightly enlarged.

Laboratory examinations revealed Blood—white blood cells, 9,200 red blood cells, 5,570,000 hemoglobin 78 per cent Wassermann reaction, negative non-protein nitrogen 31 milligrams per 100 cubic centimeters urine showed albumin + many red blood cells and an occasional white blood cell no infection.

Phenolsulphonephthalein test revealed output for first half-hour 47 per cent, second half hour 22 per cent.

A plain abdominal roentgenogram showed marked enlargement of the right kidney. It was negative for calculi. A uresectomy stereoscopic pyelogram showed a normal kidney on the left side and complete failure to excrete the drug on the right side. X ray pictures of the thorax, spine, and pelvic bones were negative for metastases.

Cystoscopy was carried out November 3, 1930. Under caudal anesthesia, 20 cubic centimeters of 3 per cent procaine, the bladder and a portion of the prostatic urethra were studied, without discomfort to the patient. There was slight enlargement of the prostatic gland. The trigone on the right side seemed to be shortened and there was slight inflammation about the right ureteral orifice which did not present the typical picture of a tuberculous infection. No function was observed on this side. The left ureteral orifice appeared normal and the function seemed to be good. A wax tip bougie was passed about 10 centimeters up the right ureter where it encountered an impenetrable obstruction. No characteristic stone scratch was obtained. All attempts to pass the point of obstruction met with failure. There was definite bleeding from the right ureteral orifice following the instrumentation, the blood flowing from the orifice in a more or less continuous, copious trickle. An obstruction probably due to a mucosal fold was encountered at about the same level on the left side,

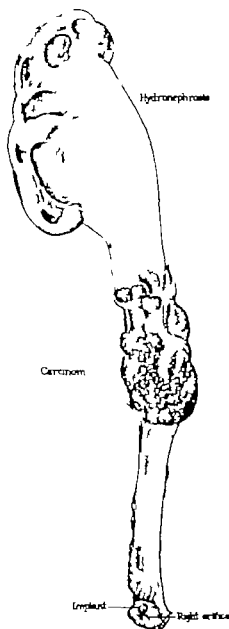


Fig. 1. Specimen removed in two sections which were combined to make a more comprehensive picture. Papillary carcinoma of the middle third of the ureter with a small implant near ureteral orifice.

but was overcome with a little difficulty. A differential kidney function study showed an output of pthalein of 70 per cent in 5 hours on the left side and only a faint trace in the transvesical specimen. An attempt to obtain a right ureterogram was unsuccessful.

At this stage we considered the possibility of primary tumor of the kidney with a secondary ureteral implant,

primary tumor of the ureter, and ureteral stricture. The continuous, rather copious flow of blood from the ureter suggested the presence of ureteral tumor.

**Operation.** Right nephrectomy November 17, 1930. Under nitrous oxide gas-oxygen ether anesthesia the kidney was approached through the extraperitoneal route. The patient was a short, thick-set individual, the kidney very large, and it was necessary to resect the twelfth rib in order to obtain a good exposure. The upper portion of the ureter was greatly enlarged and light blue in color, suggesting the presence of blood. The kidney pelvis was also many times larger than normal and of the same color as the ureter. On palpation of the pelvis it seemed as if we were dealing with blood clots within the sac. The kidney parenchyma was thin, as in advanced cases of hydronephrosis. The presence of blood in the ureter and kidney pelvis, in the absence of any findings suggesting a primary tumor of the renal parenchyma, made us at once suspect that we were dealing with a primary tumor of the ureter or a primary tumor of the kidney pelvis with a secondary involvement of the ureter. The kidney and several centimeters of the ureter were removed, care being observed not to spill any of the contents of the ureter or kidney pelvis in the wound. Two chronic ligatures were placed around the upper end of the remaining portion of the ureter. Because the patient's condition was such that a ureterectomy might be quite dangerous, a cigarette drain was placed to the stump of the ureter and the wound closed. The wound was completely healed and the patient discharged 3 weeks after operation.

At the time of discharge the patient was advised to return in 3 weeks for ureterectomy. One month later he felt so well that he did not desire to have the second operation. However a few days after this visit he again noticed blood in his urine. On cystoscopy the right ureteral orifice was found to be surrounded for a distance of about 1.5 centimeters by a red, inflamed area, which, while not typical of tumor, was suggestive either of edema due to a neoplasm of the structures beneath the mucosa or a very early growth in the mucosa.

**Operation.** Right ureterectomy and resection of portion of bladder wall, January 27, 1931 under spinal anesthesia. An oblique incision starting low in the abdomen and slightly lateral to the inner border of the rectus muscle was carried to within 3 centimeters of the umbilicus, and from there in a gradually lateral direction to a point about midway between the normal position of the tip of the twelfth rib and the crest of the iliac bone. Then the lower portion of the rectus muscle was separated and the peritoneum was carefully brought to the midline. The dilated lower ureter was easily found. The ureter was then followed toward the point of obstruction and at about the level of the umbilicus it became about 2.5 centimeters in diameter and quite indurated for a distance of 6 centimeters. It was carefully dissected free from surrounding structures until the sutured upper end was freed. Then the ureter was followed to its attachment to the bladder. At this stage the bladder was opened and the inflamed area about the ureteral orifice carefully outlined, and the mucosa and bladder wall within this area were removed with the ureter. The opening in the bladder wall was closed with chronic sutures placed externally. The mucosal surface was closed with plain catgut sutures. The vesical orifice was cut and a suprapubic tube placed in the bladder for drainage. A small drainage tube was placed external to the bladder at the former site of the ureteral orifice. The wound was closed, the patient leaving the table in good condition. He was apparently in excellent condition when discharged from the hospital 4 weeks after this operation.

**Gross pathology.** The kidney is greatly enlarged. The pelvis and ureter are dilated and filled with blood stained



Fig. 2. Low power microscopic view showing ureteral wall and transitional cell papillary carcinoma attached to it.

fluid in which there are a few small clots of blood. The calyces are greatly dilated and the cortex thin. The mucosal surface is inflamed, suggesting an infectious process. The ureter is dilated. No tumor is present in the renal parenchyma, the pelvis, and the portion of the ureter removed (Fig. 2).

Attached to the lower end of the ureter is a circular portion of bladder 2 centimeters in diameter. Just on the edge of the orifice is a small tumor implant. The mucosa about the orifice is inflamed and edematous. The lower third of the ureter is dilated. The wall is thickened and the mucosa inflamed. The upper portion of the middle third of the ureter is filled with an indurated mass and is about 2.5 centimeters in diameter and 6 centimeters in length. Above the tumor mass there is about 3 centimeters of ureter which in all respects resembled the lower third (Fig. 3).

**Microscopic pathology.** Histological specimens from the kidney were negative for tumor. The picture presented was typical of an advanced hydronephrosis plus moderate infection.

Histological report of specimen of ureter by Dr. W. B. Hawkins. Histological sections from the ureter show a papillary transitional cell carcinoma similar in type to that found frequently in the bladder. Along the ureter one finds masses of transitional cells lying beneath the mucosa, some of which show central degeneration. The picture is not unlike that seen in cystitis cystica. The cells forming these masses become more anaplastic as one approaches the main tumor. Portions of the tumor are formed of large masses of cells with a central core of fibrous tissue and vessels. These represent papillae which have been cut across. In other areas there are long papillary projections of fibrous tissue carrying blood vessels, and these are covered by epithelium, the number of layers of which vary con-

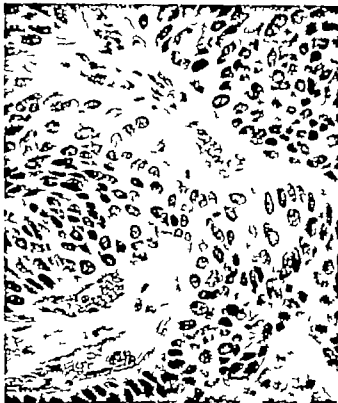


Fig. 3. Higher magnification of the same tumor showing marked variation in size, shape, and staining characteristics of cells.

siderably. The stroma is formed of delicate fibrous tissue and it appears edematous. The muscularis of the ureter shows no evidence of invasion (Fig. 2). There is some round cell infiltration of the mucosa. Some polymorphonuclear cells are seen in the tumor which is necrotic in portions. The individual tumor cells are of interest because of the varying size and shape. Mitotic figures are very numerous and all stages of division appear to be present. Some nuclei appear hyperchromatic, while others are pale and vesicular. Tumor giant cells are plentiful and show pink-staining cytoplasm with large hyperchromatic nuclei or multiple nuclei (Fig. 3).

CASE 21 W.P. S.M.H. No. 57678, aged 36 years. February 16, 1932. Patient complained of pain in right thigh and foot, recurrent hematuria, and pain in abdomen. In the Spring of 1930 the patient experienced drawing sensations and pain in the right calf and thigh. Several months later he first noticed pain in the right kidney region. In the Spring of 1931 he observed blood in his urine and a burning sensation with urination. During the summer the pain in his back became quite intense, and although he was under the care of a physician he obtained no relief. In June, 1931, his right side and leg were bruised in an automobile accident, resulting in slight immediate discomfort. However a few days later the pain in right kidney region became more intense and constant and began to radiate down the course of the right ureter to the groin. Two days after the accident the patient had gross hematuria on two occasions. One month after the accident a urologist was

The writer is deeply indebted to Dr. David Meles and Dr. Harry D. Coe, of the Rochester General Hospital, for the detailed report of the patient's course while in that institution. He also wishes to thank Dr. Harry Foster and Dr. W. B. Hawkins, of the Pathological Department of the University of Rochester School of Medicine and Dentistry, for their valuable assistance in the preparation and interpretation of the pathological studies presented.

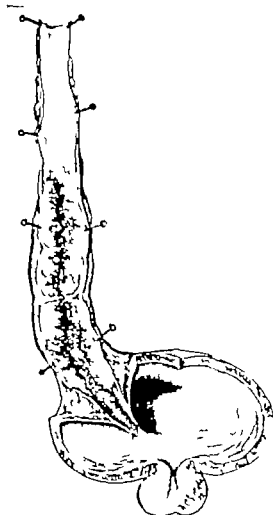


Fig. 4. Autopsy specimen showing papillary carcinoma of middle and lower third of right ureter

consulted, who found a mass in the right kidney region and obstruction of the right ureter with complete loss of function of the kidney. A right nephrectomy was performed in November 1931, by Dr. David McLen, of the Rochester General Hospital, who found a markedly dilated kidney, the pelvis of which was many times larger than normal and filled with blood clots. The upper end of the ureter was also explored, and no tumor found. The specimen removed was carefully studied by Dr. Istvan Gaspar, pathologist of the hospital, who found no tumor and made a gross and microscopic diagnosis of hydronephrotic atrophy of the right kidney. The patient had an uneventful convalescence from his nephrectomy and felt much improved when discharged from the hospital, December 5, 1931. However, it was not long before his appetite became poor, constipation became troublesome, and finally vomiting occurred. At this time blood appeared in his stools. On February 16, 1932, he visited the out-patient department of the Strong Memorial Hospital, complaining more specifically of pain in the right thigh, leg, and ankle than of other symptoms mentioned

above. It was found that he had atrophy of right buttock, thigh, and calf, beginning atrophy of right ankle and obliteration of talus and calcaneum joint. There was no palpable abdominal mass, but there was a small bleb in the upper end of the nephrectomy wound. He was advised to enter the hospital for further study but refused. Ten days later he came to the emergency department complaining of pain and mass in the epigastric region. Six days before he had suddenly experienced a sharp pain in the epigastric region, and on palpation felt a mass. This pain was almost continuous and was complicated by nausea and vomiting. Eating intensified his pain. He was taking mineral oil to insure daily bowel movement. The stools were brown and well formed. He also had pain in the right kidney region and radiating down to groin and right thigh.

The family history was unimportant. The past history was negative except for an early loss of the right ankle due to osteomyelitis 20 years before admission.

The patient showed evidence of recent loss of weight. His temperature was 37.5 degrees C. and his pulse 130. There was a draining sinus at the upper end of his nephrectomy wound. A firm, fairly hard mass, with slightly rounded edges, was felt in midline about a centimeter above the umbilicus and extending up to the xiphoid process. The mass, which moved with respiratory movements and could be displaced slightly in each lateral direction, extended about 4 centimeters to either side of the midline. Muscle spasm and tenderness over the region occupied by the mass were absent. Other positive physical findings are not considered essential in this case.

Laboratory examinations revealed the following:  
Blood—white blood cells, 12,000; hemoglobin, 65 per cent. The urine was negative for sugar and albumin. There were a few pus cells but no red blood cells.

Abdominal roentgenogram was negative.  
It was thought that the patient had either a walled-off abscess of the abdomen or a carcinoma of the stomach or transverse colon.

**Operation.** An exploratory operation was carried out and it was found that the mass in the abdomen was due to the rupture of a carcinomatous growth of the transverse colon with an early abscess formation. The abscess was drained and a colostomy performed. The patient ran a downhill course, dying on the second day after operation.

**Autopsy find.** It was found that the patient had an undifferentiated type of carcinoma of the transverse colon with metastases to the mesentery glands. There was a small draining sinus to the region formerly occupied by the kidney. The upper end of the ureter was free from tumor but the middle and lower ends were filled with a papillary growth that invaded the ureteral orifice in many places. There was a small papillary growth extending through the right ureteral orifice. The ureter was surrounded by a mass of very adherent fatty tissue in the involved regions. Metastases were found in the retroperitoneal lymph glands, in the region of the renal vessels in the right side and in the vena cava (Fig. 4).

**Histological report** was made by Dr. W. B. Hawley. Histological section reveals an enlarged ureter with large lumen, which is completely filled by a papillary transitional cell carcinoma. The papillary projections are long and formed mostly of layers of epithelial cells with a central core of fibrous tissue in which the vessels course. The tumor is sharply demarcated, with no infiltration into the wall, but there are large spaces in the muscularis which are completely filled by tumor cells (Fig. 5). The centers of some of these solid masses have undergone necrosis, and there is calcium deposition in one area of dead tissue. The tumor cells are not markedly anaplastic but mitotic figures are present (Fig. 6).



Fig 5 A Papillary carcinoma of the lumen of the lower ureter B Involvement of muscularis with a mass of tumor cells.

The small thrombus mass in the vena cava proves to be formed of tumor and the connective tissue about the vein is infiltrated by masses and strands of transitional epithelial cells. The retroperitoneal connective tissue also shows invasion by tumor with lymphatic channels occluded. There is considerable necrosis with some calcium deposition (Fig. 7)

#### PATHOLOGY

In the absence of a uniform type of nomenclature it is indeed very difficult to present an accurate histological classification. Although a review of the gross and microscopic descriptions of the tumors classified as medullary carcinomata, cylindrical cell carcinomata, etc. suggests that some of these might have originated as papillary growths, it seemed advisable from the standpoint of accurate reporting to retain the original diagnosis. The various types of tumors and their frequency of occurrence are shown in Table I

Metastases were demonstrated in 23 of the cases, while in 8 others nearby structures were involved by direct extension. The relative fre-

TABLE I.—VARIOUS TYPES OF TUMOR IN THIS SERIES 61 CASES

Type of growth	No.
Papillary carcinoma	36
Squamous cell carcinoma	9
Medullary carcinoma	7
Solid carcinoma	1
Carcinoma simplex	1
Adenosarcoma	1
Cylindrical cell carcinoma	1
Transitional cell carcinoma	1
Total	61

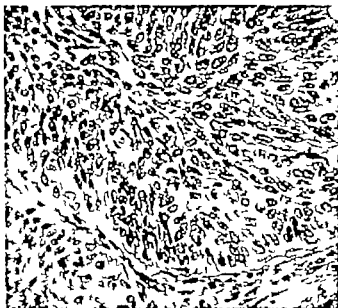


Fig 6 Higher magnification of an area from Figure 5 showing typical transitional cell papillary carcinoma.

quency of involvement of the following organs by metastases was retroperitoneal lymph glands, 17 liver 9 lungs 8 pancreas, 2 bladder 2 opposite kidney 2 and once each in the adrenal, spleen pericardium, pleura, pelvis vertebral column and skin. It would seem that metastasis from primary carcinoma of the ureter occurs earlier and more frequently than from carcinoma of the bladder

#### LOCATION OF GROWTH

The site of the primary tumors in this series is shown in Table II



Fig 7 Characteristic transitional cell papillary carcinoma structure found in thrombus mass in vena cava

TABLE II.—SITE OF GROWTH 61 CASES

Portion of ureter involved	Right ureter	Left ureter	Total
Upper third	5	6	
Middle third	6	3	9
Lower third	8	7	15
Middle and lower third	1		
Upper and lower third			
Whole ureter			
Total	14	7	6

In a small series of cases such as this the fact that the right ureter is involved a little more frequently than the left is probably of no significance. However it is interesting to speculate as to the reason for the involvement of the lower third of the ureter in 57 per cent of the cases. One wonders if it is for the same reason that bladder tumors are found more frequently in the region of the ureteral orifice and trigone.

#### AGE OF PATIENTS

In 60 cases the patient's age was given. The youngest patient, who was reported by Albarran was 33 years of age and had a papillary carcinoma. The oldest patient in this series was a man of 89 years, who had carcinoma of the left ureter.

The average of the patients' ages in this series was 55.7 years. It is interesting to note that the disease occurred with equal frequency in the fifth, sixth, and seventh decades of life.

#### THE DIAGNOSIS OF PRIMARY CARCINOMA OF THE URETER

**Symptoms.** Although it is true that the most common symptoms of primary carcinoma of the ureter are not characteristic of this disease alone, nevertheless their presence may prove to be the deciding factor in arriving at a correct diagnosis where the information derived from further studies is not quite conclusive.

Hematuria, either gross or microscopic, is the most common symptom of this disease occurring in 73 per cent of the cases. It usually appears relatively early in the disease, especially in those patients having papillary carcinomata. At first the gross bleeding is of short duration, but as the growth develops the bleeding not only increases in amount but occurs more frequently. In cases of carcinoma of the lower portion of the ureter in women it is sometimes possible to start bleeding by means of vaginal palpation.

Pain is the next most common symptom, occurring in 65 per cent of the cases. In an effort to determine if there existed any relation between

TABLE III.—AGE OF OCCURRENCE 60 CASES

Age of patient	No.
20-30	7
30-40	5
40-50	1
50-60	8
60-70	
70-80	
Total	60

the location of the tumor and the character and location of the pain resulting from it the cases in this series were divided into tumors of the upper, middle and lower ureter and each group studied separately. The only observation arising from this approach was that frequency of urination was noticed more often in those patients having tumors of the lower and middle portions of the ureter. In the cases that were somewhat more advanced the pain in the kidney region became more constant and frequently less intense and in a number of instances seemed to be due to the presence of a large hydronephrotic kidney. In those cases in which the pain is referred to the lumbar and sacral regions, the thigh, hip-joint, leg and arm, the disease is in an advanced stage and the prognosis is usually bad. In a group of 20 cases having pain in these regions not 1 patient lived more than 8 months.

**Tumor.** In 40 per cent of the cases a palpable mass was present. In most instances this proved to be a dilated kidney. However there were a few cases in which the primary growth was palpable on either abdominal, vaginal, or rectal examination.

Among the other symptoms that were less commonly observed were loss of weight, dysuria, tenderness, nausea, vomiting, right varicocele, and chills and fever in some of the infected cases.

**Other diagnostic aids.** A thorough microscopic examination of the urine is essential. In one case in this series cancer cells were found in the urine, while in another detached papillomatous villi were present.

While it is seldom that X-ray examinations yield conclusive proof of a primary carcinoma of the ureter the findings are sometimes quite suggestive and tend to support the accumulative evidence in favor of such a diagnosis. In advanced cases metastases to bony structures may be observed in the plain X-ray plate. A negative plate for stone plus the absence of a characteristic scratch on the wax tip bulb following ureteral manipulation, practically eliminates the possibility of calculus. In those cases in which ureteral calculus and traumatic stricture have been ruled out a pyelogram obtained by either the retrograde or intravenous method, showing a partially

obstructed ureter with dilatation above the point of obstruction and an enlarged kidney pelvis with no filling defects of the type seen in primary carcinoma of the renal pelvis or parenchyma suggests the possibility of primary carcinoma of the ureter, especially if there has been a story of recurrent hematuria and on cystoscopic examination blood flows copiously from the involved side in a more or less steady stream following the ureteral manipulation. The retrograde pyelograms have not been sufficiently characteristic to enable one to make a diagnosis by this means alone. With but one exception marked distortion of the ureter has been observed. The value of intravenous pyelography in this disease has not as yet been determined.

Most valuable information is frequently obtained by cystoscopic examination. In 8 cases the diagnosis was made from the observation of tumor protruding through the ureteral orifice, while in another a small implant close to the ureteral orifice suggested that the ureteral obstruction on that side was due to the presence of a primary tumor. Except in those rare cases where calculus is found as a complicating factor in primary carcinoma of the ureter a negative X ray plate for stone and the absence of a typical scratch on the wax tip bulb following ureteral manipulation practically rule out calculus. Persistent, rather copious, steady bleeding from the orifice on the involved side following ureteral manipulation with a catheter, especially in those cases where there is no history suggesting stricture due to trauma or infection is quite suggestive of carcinoma of the ureter. Bleeding of this same character has been observed following abdominal and vaginal manipulation over the site of the growth. In one case the diagnosis was made from sections of tissue removed from the ureter by means of ureteral forceps. In a very few cases of carcinoma low down in the ureter the orifice was surrounded by a bulging circumscribed area, the mucosa of which was ordematous and congested, probably due to malignant infiltration of the structures beneath.

In primary carcinoma of the lower and middle portions of the ureter a dilated, blood filled ureter and renal pelvis was a very common finding in those cases in which the operator elected to approach the problem by means of a nephrectomy with removal of the upper portion of the ureter, or a nephro-ureterectomy. The absence of tumor in the kidney pelvis and the portion of ureter removed in the presence of these findings, is another link in the chain of evidence supporting a diagnosis of primary carcinoma of the middle or

lower ureter in cases where a positive pre-operative diagnosis cannot be made.

#### TREATMENT

Forty five of the patients studied in this series were operated upon. Seventeen were given palliative treatment only the diagnosis being positively made at autopsy. In a few instances deep X ray and radium therapy were tried, but found to be of questionable value. In 1 of the writer's cases deep X ray therapy seemed to ease the pain in back for a while, but failed to stop the process of metastasis.

In order that a more comprehensive understanding of the problem presented by each operative case may be obtained a brief summary of each one is presented here (Table IV).

*Types of operation.* The absence of a pre-operative diagnosis or the presence of a wrong one, no doubt accounts for the great variety of operative procedures found in Table V.

It is quite evident that many of these operations were only performed as a palliative measure.

#### POSTOPERATIVE MORTALITY

In this group have been included all cases in which the patient did not sufficiently recover from the operation to leave the hospital in a reasonable period of time. There were 12 such cases making a postoperative mortality of 27 per cent. In 2 cases in which the patients had an advanced stage of the disease death occurred 31 and 59 days after simple exploratory operation. Another patient died of peritonitis following a colostomy for ruptured carcinoma of the transverse colon. There were 3 deaths following 9 nephro-ureterectomies. One patient died shortly after operation of paralytic ileus another on the second day, of delayed shock and a third died of uremia 1 month after operation. There were 3 deaths in a group of 9 patients who had a nephrectomy with partial resection of the ureter. One death occurred 8 hours after operation from embolus another on the third day from myocardial failure and a third 9 days after operation the cause not being clearly determined. One patient having a nephrectomy and splenectomy died 25 hours later from shock. Another patient died of delayed shock 2 days after a nephrectomy. Death from shock occurred in another case a few hours after a nephrotomy.

The high postoperative mortality in this series would seem to indicate that the character of the disease plus the relatively advanced age of the patient in the average case results in a markedly lowered resistance to operative shock. Even the



TABLE IV.—SUMMARY OF 44 OPERATIVE CASES

Reported by	Age, sex	Location and duration of symptoms	Pathology	Operation	Result
Russell and Lauen	48 F	Upper third of left ureter 6 wks	Gross large indurated tumor mass of upper third of ureter, extending to ureteropelvic junction; gynephrium renal calyx. Microscopic squamous cell carcinoma. Metastases to regional paraneural and paratracheal lymph nodes, adrenals, placenta, liver, lungs, and pleura.	Exploratory laparotomy with drainage of abscess of distal end of left ureter.	Died 31 days after operation.
D. Amey and Zander	50 F	Lower third of right ureter wk	Gross papillary growth in lower third of right ureter. Microscopic papillary carcinoma.	U. g. ect. my. Nephrectomy, 30 days later.	Well 3 yrs. after operation. (Personal communication with Dr. D. Amey.)
Ockerblom and Hefling	75 F	Middle third of left ureter 9 mos	Gross large indurated mass in middle third of left ureter, extending to above, diaphragm, surrounding renal area, and attached to gross muscle. Microscopic papillary carcinoma of left ureter. Metastases to liver.	Drainage of par. from mass.	Died 5 mos. later. Deep X-ray with-out effect.
Kretschmer	71 F	Upper third of right ureter 5 yrs	Gross indurated mass involving upper third of ureter extending almost to ureteropelvic junction. Microscopic papillary carcinoma.	Nephro-ureterectomy.	Died 3 mos. later. Mass in situ. (Personal communication with Dr. Kretschmer.)
Kraus	71 F	Lower third of ureter 8 mos	Gross tumor mass involving lower third of ureter and extending out through orifice into bladder. Microscopic papillary carcinoma.	Resection of lower 1 cm. of ureter and portion of bladder. Upper end of ureter but below it could be transplanted to bladder. 3, 4, 7 mos. probably dead.	Died 3 yrs. later. Metastases to liver. (Personal communication with Dr. Kraus.)
Dzialowsky and	63 F	Lower third of right ureter 8 mos	Gross papillary tumor involving lower third of right ureter and extending almost to ureteral orifice. Microscopic papillary carcinoma.	N. ph. t. my. Ureterectomy 6 wks later.	Well 3 yrs. after operation. Unable to follow further. (Personal communication with Dr. Dzialowsky.)
Dzialowsky and, reported by Hocher	69 M	Lower third of left ureter. Duration not given.	Gross hard, indurated mass in left ureter involving lower third. Microscopic papillary carcinoma.	Nephro-ureterectomy.	Died following operation. Paralytic then intestinal failure.
Verpahl	60 F	Lower right ureter 3	Gross carcinomatous mass arising in lower part of right ureter. Hydro-ureter. Adenocarcinoma. Microscopic medullary carcinoma. Metastases retroperitoneal lymph nodes, liver, lungs.	Nephrectomy. Partial resection of ureter.	Death 8 hrs. after operation. Symptoms of embolus.
Grumberg	50 M	Upper third of right ureter 7 mos	Gross tumor of right ureter 3.5 cm. below pelvis and extending 1 cm. and about 1 cm. in circumference. Microscopic carcinoma simplex.	Nephrectomy with resection of 9 cm. of ureter.	Died 3 yrs. later. Metastases to retroperitoneum, lungs, bones. Death of lymphatic system. (Personal communication with Dr. Grumberg.)
Lowenstein	66 F	Lower third of left ureter 12 yrs	Gross indurated mass involving lower half of left ureter. Microscopic papillary carcinoma.	N. ph. t. my. Nephrectomy.	Died 27 hrs. after operation shock.
Walker	58 not given	Right ureter 6 yrs	Gross tumor mass involving the hole of right ureter. Microscopic papillary carcinoma.	Nephrectomy. Ureterectomy not later.	Died few mos. after operation. Metastases to liver, skin, and pelvis.
Albarran	71 M	Two tumors, upper and lower third of right ureter 4 yrs	Gross two well localized tumor masses, one in upper and one in lower third of right ureter. Microscopic papillary carcinoma.	Ureterectomy and neph. ect. my. 3 mos. later.	Well 3 mos. after operation. Patient believed to have died, but not certain. (Personal communication with Dr. Albarran.)
McCaen	55 M	Upper third of left ureter. Duration not given.	Gross papillary tumor growth involving upper third of left ureter. Microscopic papillary carcinoma.	Nephrectomy with resection of upper portion of ureter.	Death 3 days after operation. Suprarenal failure.
Payne	65 F	Upper third of left ureter 3 yrs	Gross carcinomatous mass in upper third of left ureter. Microscopic papillary carcinoma.	Nephrectomy with resection of upper third of ureter.	Died of metastases 3 yrs. later.

TABLE IV—SUMMARY OF 44 OPERATIVE CASES—Continued

Reported by	Age, sex	Location and duration of symptoms	Pathology	Operation	Result
Volante	49 M	Lower left ureter 3 yrs.	Gross carcinomatous mass involving lower left ureter and extending to colon, peritoneum, spinal column, and viscera. Calculus above mass. Metastases to lymph glands and lungs. Microscopic: papillary carcinoma	Exploratory, with drainage of pus into lower left quadrant	Died 11 mos. later
Judd, Parker and Morse	54 M	Lower right ureter 8 mos.	Gross tumor mass in lower portion of right ureter. Microscopic: papillary epithelioma	Prostatectomy, nephrectomy, ureterectomy	Died 6 mos. after last op. Cause not given. (Personal communication with Dr Judd)
Metcalf and Safford	47 M	Lower left ureter Several yrs.	Gross carcinomatous mass involving lower half of left ureter and calculus. Microscopic: adenocarcinoma	Nephrectomy and resection of upper portion of ureter 3 mos. later partial removal of remaining ureter	Died of metastases 1 wk. after last operation. (Personal communication with Dr Safford)
Blatt	44 M	Lower right ureter 15 mos.	Gross indurated mass in right ureter. Microscopic: medullary carcinoma of right ureter	Nephrectomy followed by ureterectomy	Died 7 mos. later
Van Cappelen	46 F	Middle of right ureter 12 mos.	Gross mass in middle portion of right ureter. Microscopic: papillary carcinoma	Nephrectomy Ureterectomy 8 mos. later	Well 4 wks. after operation. (Further information not obtainable)
Finsterer	44 M	Lower third of left ureter 4 yrs.	Gross papillary tumor involving lower third of left ureter. Microscopic: papillary carcinoma	Resection of lower fourth of ureter and portion of bladder about orifice transplantation of ureter to bladder	Recovered from operation. Was soldier operated upon during the war and therefore lost track of. (Personal communication with Dr Finsterer)
Nissen	65 F	Lower right ureter 2 mos.	Gross tumor mass involving lower right ureter. Hematonephrosis. Metastases to retroperitoneal lymph glands. Microscopic: papillary carcinoma	Nephro-ureterectomy	Died of uremia 2 mos. later
Mixa	60 F	Lower right ureter 5 mos.	Gross fungiform enlargement just above bladder. Thickened mucosa extending around ureter. Microscopic: annular carcinoma of ureter	Uretro-nephrectomy	Died of general carcinomatosis 8 mos. later
Papla	48 M	Upper right ureter 1 mos.	Gross carcinomatous mass filling upper 4 cm. of right ureter. Microscopic: cylindrical cell epithelioma	Resection of carcinomatous portion of ureter, with transplantation of remaining ureter to kidney pelvis	Well 90 days after operation. (Further information could not be obtained)
Day Fairchild, and Martin	40 F	Lower right ureter 6 mos.	Gross tumor mass in right ureter. Microscopic: papillary carcinoma	Nephrectomy and partial ureterectomy	Died of metastases 1 yr. later. (Personal communication with Dr Day)
Stewart	76 F	Middle right ureter 8 mos.	Gross papillary tumor mass of middle of right ureter. Microscopic: papillary carcinoma	Nephrectomy and partial ureterectomy	Died 4 yrs. later aged 80 of pneumonia and cardiac failure. No urinary symptoms suggesting metastases. (Personal communication with Dr Stewart)
Gottlieb	40 F	Middle third of left ureter 18 mos.	Gross carcinomatous mass in middle third of left ureter, extending to retroperitoneal glands. Microscopic: medullary carcinoma of ureter	Nephrectomy and resection of upper portion of ureter	Recovery after operation. Further information could not be obtained. Presence of retroperitoneal glands at operation would make prognosis bad
Seiter	64 M	Lower left ureter 1 mos.	Gross papillary mass in left ureter in region of iliac vessels. Microscopic sections not made, but from description probably papillary carcinoma	Nephrectomy and partial removal of ureter	Died 6 days after operation

TABLE IV—SUMMARY OF 44 OPERATIVE CASES—Continued

Reported by	Age, sex	Location and duration of symptoms	Pathology	Operation	Result
Hest	41 M	Lower right ureter 3 yr	Gross papillary tumor in lower portion of right ureter. Microscopic papillary epithelioma.	Nephro-ureterectomy	Well 3 yr later. Further information could not be obtained. (Personal communication with Drs. Hest and Judd)
Chewen	41 M	Upper third of left ureter 3 yr	Gross two nodular tumors of upper third of left ureter. Microscopic epithelioma.	Nephro-ureterectomy	Died 3 yrs later of metastases in pelvis. (Personal communication with Dr. Chewen)
Baker	41 M	Middle right ureter 9 mos	Gross hard, cartilaginous mass in central portion of right ureter extending to psoas muscle, peritoneum, and lumbar pleura. Microscopic squamous cell carcinoma.	Exploratory	Died 30 days after operation
Zeros	36 F	Middle of right ureter 3 yr	Gross indurated, cartilaginous mass in middle portion of right ureter. Hydronephrosis and hematuria. Microscopic squamous cell carcinoma. Metastases to retroperitoneal glands.	Nephrectomy	Died following operation
Davy	41 M	Lower left ureter 3 yrs	Gross tumor mass in lower portion of left ureter involving bladder and rectum. Metastases to lumbar nodes and liver. Calculus at site of mass. Microscopic epidermoid carcinoma.	1. Nephrectomy 2. Ureterectomy	Died 3 mos later of metastases
Crane and Kuecher Becker	4 F	Lower right ureter 3	Gross tumor mass of lower right ureter. Microscopic epithelioma.	Uretero-nephrectomy	Well 3 yrs later. (Personal communication with Dr. Crane)
Acheson	48 M	Upper right ureter 3 wks	Gross indurated mass in upper portion of right ureter. Involvement of renal pelvis. Renal calculus. Microscopic squamous cell carcinoma.	Nephrectomy Nephro-ureterectomy	Died 7 mos later uremia
Funkh and Fleischer	33 F	Lower right ureter 3 yrs	Gross small tumor about 3 cm. in length, starting about 1 cm. above right ureteral orifice. Microscopic papillary carcinoma.	Nephro-ureterectomy	Recovered, but was lost track of. (Personal communication with Dr. Funkh)
Judd and Struthers	43 M	Lower left ureter 3 yrs	Gross tumor mass in lower left ureter. Microscopic papillary epithelioma.	Nephrectomy Ureterectomy with resection of portion of lower bladder wall, 3 days later	Died 3 yrs later; cause not stated. (Personal communication with Dr. Judd)
Hefmann	31 M	Lower left ureter 4 yrs	Gross tumor mass in lower left ureter. Microscopic papillary carcinoma.	Resection of ureteral orifice and lower 30 cm. of ureter; transplantation of ureter to bladder	Lost track of. (Personal communication with Dr. Hefmann)
Pomer	66 F	Middle and lower right ureter 3 mos	Gross papillary tumor in lower two thirds of right ureter and portion extending from orifice. Microscopic papillary carcinoma.	1. Nephrectomy and partial ureterectomy 2. Ureterectomy and resection of portion of bladder, 41 days later	Recovery. Further information could not be obtained.
Larnal	60 F	Lower left ureter 20 yrs	Gross papillary tumor involving lower left ureter. Microscopic papillary carcinoma. Metastases to right kidney.	Exploratory and ureterectomy	Postoperative death
Beckwith	61 F	Lower left ureter 6 mos	Gross indurated cartilaginous mass in lower left ureter, involving adjacent tissues, and in region of that vessel. Microscopic solid, richly cellular carcinoma.	Nephro-ureterectomy	Died 3 days after operation
Chen	44 F	Middle left ureter 3 mos	Gross tumor involving middle of left ureter base broad and extending through to surrounding tissues. Microscopic papillary carcinoma.	Nephro-ureterectomy	Well 3 yr later. Unable to follow further. (Personal communication with Dr. Chen)
Kirk	43 F	Middle and lower left ureter 3 mos	Gross two papillary tumors, one in middle and one in lower portion of left ureter. Microscopic papillary epithelioma.	Nephro-ureterectomy	Well July 1934 (3 yrs). (Personal communication with Dr. Kirk)

TABLE IV—SUMMARY OF 44 OPERATIVE CASES—Continued

Reported by	Age, sex	Location and duration of symptoms	Pathology	Operation	Result
Scott (Case 1)	35 M	Middle of right ureter yr	Gross carcinomatous mass involving about 6 cm. of middle portion of right ureter indurated, and contained within ureteral wall small metastatic nodules in ureteral orifice. Metastases to retroperitoneal glands and liver. Microscopic: papillary carcinoma	Nephrectomy and partial resection of ureter. Ureterectomy with resection of portion of bladder wall 3 1/2 mos. later	Condition fine for about 5 mos. Then developed pain in right side and began to lose ground. Died of carcinoma 1 mos after 2d operation
Scott (Case 2)	36 M	Middle and lower right ureter mos.	Gross papillary tumor filling entire middle and lower portion of right ureter with a small portion sticking through the ureteral orifice. Metastases to retroperitoneal lymph nodes and region of renal vessels. Entirely different type of carcinomatous growth in transverse colon. Microscopic: papillary carcinoma	Nephrectomy Four mos. later exploratory and colectomy for intestinal obstruction	Died 2 days after 2d operation peritonitis

most skillful removal of a large hydronephrotic kidney of long standing is sometimes followed by a degree of shock apparently greatly in excess of the trauma to the patient. Because this disease by its very nature lends itself to a two or even three stage operation if necessary, it would seem that close observation of the patient, plus a willingness on the part of the operator to stop before the patient is dangerously shocked would tend to decrease considerably the postoperative mortality. A ureterectomy plus a permanent nephrostomy rather than a nephrectomy may be indicated where the opposite kidney is subnormal.

#### REMOTE DEATHS IN FOLLOWED CASES

In 13 cases death from cancer due to metastases, recurrence of growth or the presence of the primary tumor, followed operative treatment. Death from metastases followed nephro-ureterectomy, uretero-nephrectomy, nephrectomy with partial removal of the ureter, nephrectomy followed by ureterectomy etc. In 9 cases it was thought at operation that all the local growth was completely removed. Nine patients died within 1 year, 1 15 months after operation 2 died of metastases 2 years, and 1, 3 years after operation.

The cause of death was either not known or attributed to some other disease in 5 cases of this series. One patient died of uremia 7 months after operation. Another died at 80 years of age of pneumonia and cardiac failure, 4 years after a nephrectomy and partial ureterectomy for papillary carcinoma of the middle portion of the ureter. At the time of her death there was nothing to suggest that she had metastases or a recurrence of the primary growth and it can be assumed that the disease was at least arrested, if not cured.

#### CASES NOT FOLLOWED

There were 11 cases in which the follow up information was not complete. In 4 instances the questionnaires were not answered and in the remaining cases the writers reported that all attempts to obtain further information were unsuccessful. Seven patients were not followed after their discharge from the hospital 1 was followed 3 months 2 12 months, and another 3 years. In view of the fact that of those patients followed after operation more than 50 per cent died within 12 months it is not unreasonable to assume that the same high percentage of deaths was maintained in those cases reported well but not followed. The one case reported well 3 years after operation but not followed further could not be considered cured, for in this series we have 1 death from metastasis that long after operation.

#### CASES FOLLOWED REPORTED WELL

Of those patients upon whom the follow up information is complete only 2 are reported living and well more than 5 years after operation. One patient reported by Kraft is well 11 years follow.

TABLE V—OPERATIVE PROCEDURES, 44 CASES

Operation	No.
Nephro-ureterectomy	0
Nephrectomy and partial resection of ureter	9
Nephrectomy followed by ureterectomy	4
Exploratory laparotomy	5
Nephrectomy followed by ureterectomy and resection of portion of bladder wall	1
Ureterectomy followed by nephrectomy	1
Uretero-nephrectomy	2
Resection of lower end of ureter with portion of bladder wall and transplantation of ureter	1
Prostatectomy followed by nephrectomy and ureterectomy	1
Nephrectomy and splenectomy	1
Resection of lower ureter with transplantation to bladder	1
Resection of lower end of ureter—upper end lost in wound	1
Nephrectomy	1
Nephrectomy followed by exploratory laparotomy and colectomy	1
Nephrectomy followed by nephrectomy	1
Nephrectomy followed by nephro-ureterectomy	1
Nephrectomy	1
Total	44

ing a nephro-ureterectomy for papillary epithelioma of the lower portion of the left ureter. A patient reported by Knickerbocker and Crance is well 8 years after a uretero-nephrectomy for an epithelioma of the lower portion of the right ureter. In the case reported by Stewart the disease was probably arrested, for when the patient died of pneumonia and cardiac failure at the age of 80 4 years after a nephrectomy and partial ureterectomy for a papillary carcinoma of the middle of the right ureter there were no symptoms pointing toward a local recurrence or metastases to other organs. The patient reported by Dr. D. Aunoy is well 2 years after a ureterectomy followed by a nephrectomy for papillary carcinoma of the lower portion of the ureter but of course it is much too soon to draw conclusions concerning the ultimate result in this case.

#### CHOICE OF OPERATION

The type of operation indicated depends not only upon the location and character of the tumor but upon the patient's condition as well. Where the tumor is small and in close proximity to the bladder it is sometimes possible to resect the involved area and transplant the remaining end of the ureter into the bladder. Also, if from the character of the growth an operator can with reasonable certainty rule out the possibility of implants to the lower portion of the ureter from a small tumor close to the ureteropelvic junction resection with transplantation of the stump of the ureter into the renal pelvis should be considered especially if the kidney happens to be worth saving. In cases in which the transplantation is impractical, or in which there is any doubt as to the possibility of tumor implants in the remaining portion of the ureter the ureter and its kidney should be removed provided the opposite kidney is functioning satisfactorily. The decision as to whether the operator should perform a uretero-nephrectomy or a nephro-ureterectomy, or should follow the more conservative method of removing either the kidney or ureter first and the remaining organ as soon as the patient's condition permits, must necessarily be based upon the results of the pre-operative study in each case. If there is any reason to fear that the kidney on the uninvolved side will be unable to carry the burden alone it would seem advisable to remove the involved ureter and perform a permanent nephrostomy on its kidney. In suspected bladder wall involvement near the ureteral orifice either by means of direct extension or a tumor implant, this area with a safe margin should be removed with the ureter. Because of the extremely high mortality

in late stages of this disease, an exploratory operation seems justifiable in early cases if this diagnosis is strongly suspected but not clearly proved.

#### SUMMARY

1. Primary carcinoma of the ureter is a relatively rare disease, there being only 61 acceptable cases in the literature.

2. The most common type of tumor is the papillary carcinoma.

3. The disease occurs with equal frequency in the fifth, sixth and seventh decades of life. The average age of patients in this series was 55 7 years.

4. The right ureter seemed to be involved slightly more frequently than the left, and the lower third of the ureter was involved in 57 per cent of the cases.

5. Increased knowledge concerning the behavior of this disease, as well as the marked advances in the technique of urological diagnosis, should result in earlier diagnosis.

6. The postoperative mortality in this series was 27 per cent.

7. Of those cases followed, only 2 patients are reported well more than 5 years after operation.

8. Early diagnosis and radical surgical removal offer the greatest chance for cure.

#### BIBLIOGRAPHY

- ADLER, L. *Monatsh. f. Urol.* 1905, x, 39.
- ALABRAM, J. *Ann. d. med. gén. urém.* 1900, xviii, 918.
- ASCHNER, P. W. *Surg. Gynec. & Obst.* 1932, lxxv, 749.
- BLATT, P. *Wien. klin. Wchnschr.* 1936, xlviii, 130.
- BUTLER, F. A. *Chilton Med. Bull.* 1914, li, 48.
- CHIVASSO, M. and BLOCH, J. *Bull. et mém. Soc. de chir. de Par.* 1918, xxviii, 522.
- CHIALI, O. M. *Zschr. f. Urol.* 1914, viii, 673.
- CRANCE, A. M. and KNICKERBOCKER, H. J. *J. Am. M. Ass.* 1924, lxxvi, 9013.
- D. AUNOY, R., and ZOFER, A. *Arch. Path.* 1930, li, 7-30.
- DAVIS, R. *Brit. M. J.* 1884, li, 757.
- DAY FAIRCHILD, and MARTIN. *Surg. Gynec. & Obst.* 1935, li, 486.
- DELABORTYNSKI, A. *Zschr. f. Urol.* 1930, xliii, 404.
- FRIEDRICH, H. *Wien. klin. Wchnschr.* 1935, xlvii, 718.
- GLAS, R. *Wien. klin. Wchnschr.* 1936, xlviii, 1145.
- GOTTLIEB, J. *Zschr. f. Urol. Chir.* 1906, xv, 230.
- GRUNBERG, JULIUS. *Zschr. f. Urol.* 1930, xlv, 860.
- HEKTOBY, L. *J. Am. M. Ass.* 1896, xvi, 1-5.
- HOFMANN, K. R. *Zschr. f. Urol.* 1916, x, 366.
- HUNT, V. C. *Surg. Clin. N. America*, 1927, ii, 1464.
- ISRAEL, J. *Berl. klin. Wchnschr.* 1910, xlvii, 2381.
- JOSCA, G. *Centralbl. f. allg. Path. u. path. Anat.* 1904, v, 659.
- JUDK, E. S., and STROTHERS, J. F. *J. Urol.* 1931, li, 215.
- JUDK, E. S., PARKER, B. R., and MORT, H. D. *Surg. Clin. N. America*, 1936, vi, 43.

24. KNEKE, OTTO. *Ztschr f. Urol.*, 1930 *xxix*, 10.
25. KNACK. *Deutsche med. Wchnschr.*, 1918, *xliv*, 98.
26. KRAFT S. *Ztschr f. urol. Chir.*, 1922 *xvi*, 335.
27. KRETSCHEIDER, H. L. *Surg., Gynec. & Obst.* 1924 *xxviii*, 47.
28. LOWENSTEIN E. Inaugural Dissertation, Freiberg, 1911.
29. MEERER, L. H. and MCCARTHY J. *J. Am. M. Ass.*, 1923, *lxxxi*, 104.
30. McCOWN P. E. *J. Am. M. Ass.*, 1930, *xciv*, 468.
31. METCALF W. F., and SUTTON, H. E. *Am. J. M. Sc.* 1905 *ccix*, 50.
32. MIXICH, K. *Pest med.-chir. Presse*, 1902 *xxviii*, 941.
33. MIRAL, J. Z. *J. Urol.*, 1924, *xii*, 40.
34. NILSEN A. *Kristiania kirurg. forh.* 1915 *xlii*.
35. OCKERBLAD N. F., and HELWIG, F. C. *J. Urol.* 1930 *xxiv*, 451.
36. PAPPY M. *J. d. urol.*, 1924, *xvii*, 325.
37. PASCHER, R., and PLESCHNER, H. *Med. Klin.*, 1920, *xvi*, 1254.
38. PAYER, L. P. *Urol. & Cutan. Rev.* 1928 *xxxii*, 418.
39. POMER, H. L. *Monatschr. f. Geburtsh. u. Gynaek.* 1926, *lxxv*, 86.
40. RICHTER, J. *Ztschr f. Urol.* 1909, *iii*, 416.
41. ROUSSELOT L. H. and LAMEN J. D. *Surg., Gynec. & Obst.* 1930, *i*, 17.
42. RYNDLE H. *Tr. Path. Soc. Lond.* 1896, *xlvii*, 128.
43. SCHEELE, K. *Fortschr. a. d. Geb. d. Roentgenstrahlen*, 1927 *xxvi*, 825.
44. SCHMITT E. C. *Am. J. Cancer Res.*, 1916 *i*, 461.
45. SPIESS, P. *Centralbl. f. allg. Path. u. path. Anat.*, 1915 *xxvi*, 553.
46. STEWART R. L. *Brit. J. Surg.* 1925-1926 *xlii*, 667.
47. ST. THOMAS HOSPITAL REPORTS 1904 *xxxii*, 90.
48. SUTER, F. *Ztschr f. urol. Chir.* 1922 *x*, 522.
49. TOUPET H., and GUESNOT P. *Bull. Soc. anat. de Par.*, 1898 *lxxiii*, 677.
50. VAN CAPPELEN D. *Beitr. z. klin. Chir.* 1916 *xciv*, 138.
51. VOELCHER, A. F. *Tr. Path. Soc. Lond.* 1895 *xlvi*, 133.
52. VOLANTE, F. *Arch. Ital. di urol.* 1927 *iv*, 105.
53. VORPAUL, K. *Am. J. Urol.* 1905 *ii*, 509.
54. WALKER, J. W. T. *Proc. Roy. Soc. Med. (Sect. Urol.)* 1921 *xiv*, 42.
55. WIRING P. J. and BLEX, C. *Hygiea* 1878 *xi*, 468.
56. ZEROWI G. *Ann. d. mal. d. org. génito-urina.* 1909, *ii*, 81.
57. ZOBEL, H. V. *Centralbl. f. allg. Path. u. path. Anat.* 1925 *xxvi*, 142.

## THE CARE OF THE SURGICAL DIABETIC

## A REPORT OF TWO HUNDRED AND TWO CASES

ELAINE P. RALLI, M.D., AND SAMUEL STANDARD, M.D. F.A.C.S. New York

From The Third (New York University) Medical and Surgical Divisions, Bellevue Hospital and The Departments of Medicine and Surgery The University and Bellevue Hospital Medical College, New York University

THE wealth of literature (1, 3, 5, 7) that has appeared on the care of the surgical diabetic since the discovery of insulin may be taken as a fair index of the increased incidence of surgery in the diabetic and of the increased importance of surgery to the diabetic patient. This increase in surgical complications may be attributed to the increased span of life resulting from the intelligent use of insulin and diet in these patients.

The treatment of the surgical diabetic is still not without difficulty. It is our impression, however, after 4 years' experience on the wards of the Third (New York University) Divisions of Bellevue Hospital, that these difficulties can be reduced to a minimum by the adoption of a routine method of procedure. Such a procedure should be applicable in a general way to all surgical diabetics and yet be sufficiently elastic to allow for the individual case. This report is concerned with the application and results of our method of treatment in 96 patients operated upon and 106 non-operated upon surgical cases.

It seems a bit obvious to point out that to facilitate and expedite the treatment there must be co-operation between the medical and surgical services of the hospital. We have found that this is readily accomplished by having one member of each staff primarily responsible for the treatment of the diabetic patients. So that no time is lost in starting treatment in such cases, the interne staff of both services is instructed in the handling of such patients and is responsible for the urinary tests.

When the operation is one of choice and the patient can be treated by diet for several days before operation, we place the patient on a diet of

Carbohydrate	80 to 200 grams
Protein	70 to 80 grams
Fat	75 to 85 grams

Enough insulin is given before meals to render and keep the patient sugar free.

The immediate pre-operative treatment of the diabetic patient depends on the type of operation, the approximate length of time required for the operation, the type of anesthesia, and the urinary tests. Actually in estimating the pre-opera-

tive dose of insulin, the two most important guides are the urinary tests and the type of anesthesia that are to be used. The former indicates the degree of ketosis, the latter determines whether the patient will be conscious and able to take food by mouth 2 or 3 hours after operation, without vomiting. We use the following simple guide to estimate the dose of insulin.

## Guide for non-ether anesthesia

Urine sugar	None	Freq.	Pres.	Pres.
Urine acetone	None	None	Tr	++++
Glucose-dose gms	35	35	35	35
Insulin dose units	10	5	25	40

When ether is to be used, the dose of insulin is increased 5 or 10 units. More glucose may be used if desired; we give up to 50 grams.

**Time.** The glucose is given 2 or 3 hours before operation. If however immediate operation is necessary the operation is started sooner and more insulin is given after the operation.

**Form of glucose.** In operations not involving the abdomen or pelvis the glucose may be given by mouth as orange juice, ginger ale, or tea, with glucose. Whenever it is thought that the patient may vomit or in abdominal and pelvic operations, the glucose is given by infusion—usually in 500 cubic centimeters of normal saline. As a matter of fact we are now giving the glucose by this method in amputations and in severe infections, such as carbuncles, as the patient is usually dehydrated and we find the infusion a distinct aid in the treatment. If the operation requires more than  $\frac{1}{2}$  of an hour the amount of glucose should be increased to 50 grams and the insulin increased correspondingly.

**Postoperative treatment.** 1. Immediately after operation the patient is given an infusion of 1,000 cubic centimeters of normal salt solution containing 50 grams of glucose. An initial dose of insulin is given with this, the amount being determined by the results of the postoperative urinary tests. Almost the same guide for insulin dosage can be used for this as is used before operation. Too much stress cannot be laid on the importance of the urine specimens after the operation. Both the volume of the specimens and the amount of sugar

and acetone present are important. The former is an index of any tendency toward anuria and the latter to the patient's insulin requirement.

2. Feeding of the patient. If the patient is able to take fluids by mouth feedings are begun 2 hours after the infusion is finished. Our aim is to give 25 to 30 grams of carbohydrate every 2 hours for 4 doses. The carbohydrate must be given in a form that is readily absorbed and not nauseating. We have found the following combinations useful:

- Orange juice 150 grams  
Ginger ale 150 grams plus  
Glucose 5 grams
- a bit of lemon juice may be added if this is too sweet.
- Oatmeal gruel. This is made with 15 grams of dry oatmeal, 100 grams of milk and 5 grams of glucose.
- Hot tea with 10 grams of glucose and 3 Uneda biscuits.
- 100 grams of milk and 3 Uneda biscuits.

After the feedings every 2 hours, the interval of time between feedings is extended to 3 hours. In this way the patient receives 200 grams of carbohydrate in the 24 hours. The character of the food may be altered somewhat at this time and protein may be added to the feedings as desired, principally in the form of egg white. Usually at the end of this time the patient is able to tolerate a semi-solid diet and he is started on

Carbohydrate	180 grams
Protein	70 grams
Fat	75 grams

In addition, he is given 20 grams of carbohydrate in the form of orange juice at night, about 11 p.m. to avoid the long interval between supper and breakfast. In some cases if the patient is a very severe diabetic, these feedings of carbohydrate are necessary between the other meals as well or it may be necessary to give two feedings at night one at 10 p.m. and one about 2 a.m.

When patients cannot take food after the operation, glucose must be given by infusion, clysis or by rectum. The best method is to give two infusions, each containing 50 grams of glucose in 1,000 cubic centimeters of normal salt solution, and two clyses, 1,000 cubic centimeters each with 50 grams of glucose. This gives the patient 200 grams of carbohydrate in 24 hours and 4,000 cubic centimeters of fluid which help guard against ketosis and dehydration. We have, in some cases, continued this treatment for 3 days, usually however it is only necessary for 24 to 48 hours. One other method of administering glucose is by Levine tube. The rectal route is somewhat uncertain (6) as far as the absorption of glucose is concerned, but it is, of course, an excellent way of increasing the fluid intake.

3. Postoperative insulin administration. The exact amount of insulin to be given depends on

the amount of sugar and acetone in the urine specimens. In very mild cases it is enough to give insulin with every other dose of carbohydrate in severe cases, with every dose.

a. With the first infusion if the patient is sugar and acetone free 10 units of insulin are given. If the patient continues sugar and acetone free, 5 units are given with each 25 gram feeding, and if the patient still continues sugar free insulin is given only with every second or third feeding.

b. If the patient shows no acetone but the reaction to Benedict's is a cloudy green, 15 units of insulin is given at the start of the infusion.

c. If the reaction to Benedict's test is green with an orange precipitate or orange, the dose of insulin is increased to 20 or 30 units.

d. The doses with each feeding of carbohydrate are increased in a similar manner, depending on the urinalysis. The effort is naturally to keep the patient from going into a state of ketosis. The patient must be watched carefully. It is impossible to detail the entire postoperative treatment, but an outline of the probable dosage can be given, with orders to modify the treatment according to the urinalysis. Insulin shock must be avoided and this can be accomplished only by modifying the amount of insulin according to the results of the urine test. There is nothing alarming if small amounts of sugar are present in the urine. This is quite usual during the first 48 hours. The important thing to avoid is ketosis which is evidenced by the presence of acetone in the urine.

Examples of some of the cases treated

CASE 1. Carbuncle of neck extending across entire back of neck. Female (M.B.) aged 58 years, had had diabetes for 5 years. On admission to the hospital patient was dehydrated and in impending diabetic coma. Urinalysis showed sugar 6 per cent, acetone, 4 plus, diacetic acid 3 plus. Examination of blood showed sugar 333 milligrams.

To combat the dehydration, a saline infusion of 1,000 cubic centimeters was given with 50 grams of glucose. In addition, the patient was given a clysis of 1,000 cubic centimeters with 100 grams of glucose. Insulin was given in large doses every half hour—a total of 195 units being given before operation during a period of 3 hours. The patient was operated on under ether and gas anesthesia. Post-operative laboratory examinations showed of the urine, sugar 5 per cent, acetone, negative, diacetic acid, negative, of the blood, sugar 250 milligrams. Treatment consisted of administration of a clysis of 1,000 cubic centimeters with 100 grams of glucose and during the time it took to give the clysis a total of 60 units of insulin was given. The patient was then put on a hour feedings. The patient was in the hospital 50 days. The infection cleared up completely but the patient always required large doses of insulin.

This was a very severe infection accompanied by profound ketosis and required vigorous diabetic treatment.



**CASE 2.** Carbuncle of neck. Male 48 years of age. When patient entered the hospital he showed no ketosis and no dehydration. Urinalysis revealed sugar 1 per cent; acetone, negative. Blood sugar test was not done. Treatment consisted in the administration of glucose, 35 grams; insulin, 15 units. The carbuncle was excised under general anesthesia. Postoperative laboratory urinalysis revealed no sugar or acetone.

Patient was given a cystis of 2,000 cubic centimeters—a total of 75 grams of glucose was given and he required only 15 units of insulin with this. Patient proved to be a very mild diabetic requiring only 5 units of insulin daily. He remained in the hospital one week.

**CASE 3.** Abscess of thigh apparently from *Isavella* infection. Female, 33 years. Duration of diabetes, 3 years. On admission to hospital patient showed a moderate ketosis and dehydration. Urinalysis was negative for sugar; acetone, 3 plus. Blood sugar was 87 milligrams.

Patient was given 35 grams of glucose and 30 units of insulin. The abscess was incised under general anesthesia. Postoperative laboratory examinations showed urine negative for sugar; acetone, 1 plus. Blood sugar was 74 milligrams.

Patient was given immediately after operation 35 grams of glucose and 30 units of insulin. Fluids were forced by mouth. Patient was able to take her diet the next day but required a night feeding with insulin. Remained in the hospital one week.

**CASE 4.** This patient was admitted with an infection of the right hand and thumb. On the first operation the infection was incised—on the second operation the thumb was amputated.

E. M. female, aged 27 years. The laboratory findings and doses of insulin were as follows.

	Pre-operative	Post-operative immediate	hrs.	hrs.	4 hrs.
Blood sugar mgm.	14				
Urine sugar per cent	5%				
Urine acetone					
Grams glucose given	5	5	5	5	5
Units insulin given	5	5	5	5	5
Fluids given	Forced by mouth				

After the first operation and before the second operation the laboratory findings and treatment were as follows:

	Pre-operative	Post-operative immediate	hrs.	hrs.	6 hrs.	8 hrs.	9 hrs.
Blood sugar							
Urine sugar	1%						
Urine acetone							
Grams glucose given	13	5	5	5	5	5	5
Units insulin given	5	5	5	5	5	5	5
Fluids given	Forced by mouth						

#### CASES 5 and 6. Gall bladder.

	G. B.	C. F.
Age, sex:	43, female	43, female
Duration of diabetes:	5 years	7 years
Surgical diagnosis:	cholecystitis	acute cholecystitis
Condition on admission:		
Ketosis:	moderate	moderate—carbon-dioxide, 30 per cent
Blood sugar	260 mgm.	222 mgm.
Urine sugar	1.8 per cent	4 plus
Acetone	4 plus	4 plus

#### Treatment:

Treated for diabetes for 5 days before operation.	Operated upon with- in 12 hours
Immediate pre-operative findings:	
Blood sugar	125 mgm.
Urine	Sugar free
Insulin	15 units
Glucose	35 grams
Immediate postoperative data:	
Blood sugar	70 mgm.
Urine	Trace of sugar
Acetone—	negative
Glucose	50 grams
Insulin	15 units
Fluids	Infusion
	900 ccm.
Course	Discharged in 37 days

**CASE 7.** A. T., male, aged 61 years. Mid-thigh amputation.

	Pre-operative	Post-operative immediate	hrs.	hrs.	6 hrs.	11 hrs.
Blood sugar						
Urine sugar						
Urine acetone						
Grams glucose given	45	30	30	30	30	30
Units insulin given	10	8	5	5	5	5
Fluids given	cm	(1200)				

**CASE 8.** J. W., male, aged 51 years. Amputation lower part of leg.

	Pre-operative	Post-operative immediate	hrs.	hrs.	7 hrs.	8 hrs.	9 hrs.
Blood sugar							
Urine sugar	8+	6+	4+				
Urine acetone							
Grams glucose given	13	30	5	30	30	30	30
Units insulin given		5	5	5	5	5	5
Fluids given	cm	(1200)					

#### SUMMARY AND CONCLUSIONS

The diabetic patient should not be denied surgery because of his diabetes. Properly treated he will prove a safe surgical risk. With this in mind surgery in the diabetic should be extended beyond the limited scope of emergency life saving operations. He should be accorded surgery that not only saves life but also makes life more livable. A hernia or a relaxed perineum may be repaired, an infected gall bladder drained or removed, and a chronic or acute appendix removed as in any other person. In acute infections, surgical interference is particularly indicated in patients with diabetes. Infection is a serious menace to the diabetic patient, so increasing the severity of his diabetes that he may readily go into coma. The diabetes in such cases is an added indication for the removal of the infected part.

Chart 1 shows the number of cases and the types of treatment, with the number of deaths in



limb already the site of vascular inadequacy will produce sufficient additional trauma and pressure occlusion of the vessels to cause gangrene. All such minor procedures should be done under gas oxygen anesthesia.

As to anesthetics, the most desirable is the one that leaves the patient conscious following the surgical procedure. Any anesthetic that tends to produce liver damage (2) is particularly to be avoided. This means specifically chloroform and to a somewhat lesser degree ether. For surgery not involving the abdomen, we prefer gas oxygen for laparotomies we prefer to use subarachnoid block. We have had no experience with ethylene Avertin may be used, but preferably only as a basal anesthetic, to be supplemented with gas oxygen.

In the past 4 years we have admitted 102 surgical diabetic patients. In these there was a mortality of 12 per cent. Of this total 96 came to operation. The mortality in the operated upon cases was 16.4 per cent. The operations included amputations, carbuncles, laparotomies for acute empyema of the gall bladder, cholelithiasis, acute appendicitis, and a group of elective surgical cases. In 36 major amputations there were 12 deaths. Four of the patients who died were extremely ill on admission. Of the amputations, five were done below the knee after the method described by Dr Beverly C. Smith. None healed by primary union. All healed in 8 to 10 weeks. None required skin grafting and none required reamputation. In 16 radically excised carbuncles there were 2 deaths.

The non-operated upon group included some patients who refused operation, and some in whom palliative treatment was advised. Of the 15 cases with gangrene not operated upon 3 died, the others were treated with a cradle, dry heat, and when the infection subsided, with Buerger's exercises. The results in the 12 remaining cases were moderately encouraging, but it remains to be seen how long these patients will continue to have an adequate vascular supply to the extremity involved. When patients with infections were not operated upon they were treated with wet dressings and rest in bed, with satisfactory results. Fractures were not counted as operations, as the

setting of a fracture causes no particular disturbance to the diabetic patient.

The cause of death following surgery in the aged diabetic is not primarily due to a disturbed carbohydrate metabolism, but rather to the diffuse arteriosclerosis. This may involve all their vessels, cerebral, coronary and renal as well as those of the extremities. Only those of the extremities are amenable to surgical treatment and the diffuse vascular inadequacy is still beyond our scope. Their death is often one of circulatory failure, kidney insufficiency or cerebral accident.

Only in the severe infections is the treated surgical diabetic liable to die of his diabetes. In none of our cases can we truly hold the diabetes itself immediately responsible—that is, none of our patients died in coma. However, the treatment in severe cases is vigorous and an individual who has had a disturbed carbohydrate metabolism with the consequent disturbance of fat metabolism has profoundly upset the chemistry of the body. The readjustment of this is sometimes difficult and, for this reason, any additional burden such as insulin shock, should be avoided.

For the most part, however, the treatment of the surgical diabetic is not difficult. It requires a little more effort and care on the part of the physician—and it necessitates frequent urinalyses. As is so often the case, when a routine for such treatment has been established and the importance realized one is hardly conscious of the additional effort.

We are indebted to Dr Harold Brandaleone for his assistance in working up these cases and in tabulating the results.

#### BIBLIOGRAPHY

1. ABRAMSON P. D. *Ann. Surg.*, 1932, *xvii*, 49.
2. DAVIS, N. C., HALL, C. C. and WATKINS, G. H. *Arch. Int. Med.* 1919, *xviii*, 711.
3. McKITTRICK, L. S., and ROOF, H. F. *Diabetic Surgery* Philadelphia. Lea and Febiger, 1928.
4. ROSENTHAL, S. M., and BOURQUE, W. *J. Am. M. Ass.* 1938, *xc*, 377.
5. SAWYERS, E. W. *Ann. Surg.* 1933, *xviii*, 16.
6. SCOTT, E. L. and ZWISLOCKI, J. F. *B. Arch. Int. Med.* 1933, *xliii*, 21.
7. WITTEKAMP, J. T. *Am. J. Surg.* 1933, *xvii*, 415.

FIVE YEAR RESULTS OF SUPRAPUBIC RADIUM IMPLANTATION INTO BLADDER TUMORS<sup>1</sup>

EDWARD L. KEYES M.D. F.A.C.S. NEW YORK

## RESULTS

THE case histories that form the basis of this paper constitute a continuation of the histories of 31 patients with bladder tumor treated by suprapubic implantation of metal capsules (which are referred to in the text as radons<sup>2</sup>) containing radium emanation. These 31 cases have been previously reported and the method of operation described.<sup>3</sup> They are the first 31 cases operated upon by me by this method. The operations were performed between December 1925 and March, 1928. The 5 year results of these operations are quite gratifying in spite of the fact that four cases have been included (Cases 4, 15, 16, 17) whose initial treatments were made by resection (Case 4) or by radium implantation through less satisfactory methods, 2 with glass seeds and 2 with steel needles containing radium element. All these 4 patients have died of carcinoma.

Moreover many of these patients received a lower dosage of radium than would be employed today. We now use 2 millicurie radons<sup>4</sup> in place of the 1 millicurie or 1.5 millicurie radons that we employed on so many of these patients. One (Case 13) definitely had insufficient radiation. The tumor was controlled for 2 years. Quite possibly had a larger number of radons been implanted the ultimate result might have been better.

For these reasons and because of what seem more promising results obtained on patients who have been operated upon since this series, we feel that the results here presented are minimal.

In the previous report 2 deaths from operation are recorded one 3 days after suprapubic implantation of radium, the other a death due to ileus following resection of the bladder for persistent tumor of the vault after repeated radium implantation had failed.

This is the only resection performed in the series, and so excellent have been the results of radium implantation that in the intervening years but 2 cases have been resected and 1 submitted to total cystectomy. All of the other operable cases have been treated by radon implantation if they were too extensive or too malignant for fulguration.

In the previous report results were tabulated after dividing the cases into four groups: papilloma and grade I, grade II, grade III, and grade IV. The typing was done by a combination of clinical and pathological observations somewhat similar to that employed by Dr. Barringer in 1928. In most instances slides of the tumors were preserved and have been subsequently graded by the American Urological Association Carcinoma Registry. The results are instructive. Three cases (Cases 1, 2 and 3) that had been previously graded I were placed by the Registry as a papilloma, a grade II and a grade III. The 2 cases (4 and 5) graded II were placed as grades I and I plus. The 12 cases graded III (6 to 17) were again graded III with 4 exceptions which were graded II. The 14 cases graded IV (18 to 31) which grossly and palpably infiltrated the bladder wall with hard masses of tumor 11 were regraded as III and IV with one exception, graded as II and of interest as the only survivor in this group. A brief history of this patient seems worth repeating.

CASE 29. Male, 67 years of age, had had intermittent hematuria 2 years. Bimanual examination revealed a vague resistance and thickening in the bladder region. Cystogram showed the bladder pushed to the left. Cystoscopy was interfered with by bleeding. There seemed to be an infiltrate all across the base of the bladder.

In March, 1927, under spinal anesthesia, the bladder was opened and "an infiltrating tumor was found which when first seen appeared as a papillary growth surrounding the urethra and growing chiefly from the right side of the trigone and adjacent bladder wall—its base extended about 3 by 3 centimeters to the right of and below the urethral orifice and all the way around in front of the urethra and about 3 centimeters up the right side of the bladder along the line of the ureter. Thirty radons of 1 millicurie each were implanted in the growth with counter pressure by finger in rectum to identify the depth of the growth which in only one place seemed to need one radon deeper than another." Bladder sutured without drainage, broke open on the sixth day, healed on the twenty sixth.

In February, 1928, there was a recurrence of a most malignant looking type on the opposite side of the bladder. The mucosa was lifted up and the tumor seemed to break through it. Into this 4 radons each containing 2.5 millicuries were implanted through the cystoscope. Specimen reported grade II.

Repeated negative cystoscopies were made since that time, the last in September 1931 5½ years after operation and 4½ years since the operative cystoscopy. The patient reported himself well by letter in May 1933.

<sup>1</sup> Ann. St. Ann. 1931, 5, 1705.<sup>2</sup> Ann. Am. of Gen-Urin. Surg., 9:28 xxi, 127. J. of Urology 1927 xvi, nos. Arch. Franco-Belge de chir., 1928, August.<sup>3</sup> Series of 3 in gold.<sup>4</sup> The cases herein reported were previously reported by the T. Am. Am. Genito-Urin. Surg., 9:28 xxi. In order to avoid confusion the case numbers in that communication have been retained in this.

It is interesting to compare the prognostic accuracy of the older methods of more or less combined clinical and pathological malignancy with the modern grading. According to the older classification there were 8 tumors in grades I and II. Of these only 1 died (12.5 per cent). There were 12 grade III tumors, 2 died of operation and 3 of carcinoma, making an almost 50 per cent mortality. One of these patients lived 3½ years, another 3 years from the original treatment. Thirteen of the 14 clinically grade IV patients died of carcinoma, 1 after 27 months, 1 by suicide because of blindness due to wood alcohol but with the fistula still open (Case 30) and very likely with tumor still in him 3½ years after operation, and 1 remained well and working 6 years and then died of carcinoma while Case 29 cited is the only survivor.

In contrast to these the American Urological Association pathological grading omits 1 of the cases as a papilloma (surviving) and 7 as ungraded (5 died of carcinoma. Case 22 in 3 months. Case 24 in 4 months. Case 27 in 11 months. Case 4 in 2 years. Case 30 committed suicide at 3½ years, fistula still open and carcinoma probably present while 2 survived and are well over 6 years) and classes the others as follows:

There are 2 grade I, 1 well after 3½ years (cystoscopy) and then lost sight of, 1 well 5½ years.

There are 6 grade II, 1 patient cystoscoped and found free from tumor 5 months after operation and then lost sight of, 3 others well at the end of 4, 5½ and 6½ years, 2 died (Cases 15 and 16) each of whom had the original treatment by radium element and not by radons.

There are 12 grade III, 3 survivors, 2 operative deaths, 7 cancer deaths (at intervals of 5, 7, 8, 13, 18 and 27 months, and 3½ years) survivors well and free from cancer at 5½, 5½ and 6 years (the 6 year survivor was graded III plus).

There are 3 grade IV, all died of carcinoma, 1 at 7 months, 1 at 13 months and 1 at 6½ years (Case 3). This man had remained at work and supposed himself well for 6 years after the radium implantation.

No deaths by intercurrent disease.

The mortality for the whole series (by operation, 2 by carcinoma, 17) was 61 per cent, the 5 year cures 29 per cent. Excluding the 7 ungraded cases and Cases 15, 16 and 17 the treatment of which was begun by earlier methods, and the papilloma (Case 3, well 6 years) the graded cases are classified as follows:

In grades I and II were 6 cases, no deaths, 1 cure verified 5 months, the others 3, 4, 5 (twice) 6 years.

In grade III were 11 cases, 1 operative death, 7 carcinoma deaths, 3 cures followed over 5 years (mortality 73 per cent, 5 year cures 27 per cent).

In grade IV were 3 cases, all dead within 7 years.

The discrepancy between the results of the clinicopathological grading of 1928 and the American Urological Association grading here reported is not great in sum but is important in detail. To this day I cannot clinically distinguish papilloma from grade I, II, or III carcinoma, nor in the clinically infiltrating group, grade II from III, or IV. Case 29 cited, seemed to me as malignant a case as I had ever seen. Grading and survival proved me wrong. Subsequent experience confirms the impression that tumors microscopically grouped under grades I or II are almost as curable by radium as papilloma and should scarcely fall within the popular conception of cancer. Metastasis occurs so late that almost the most neglected cases should be curable by cystectomy.

Unfortunately the majority of bladder tumors that have seemed to me malignant enough or extensive enough to merit open operation are of grades III or IV (60 per cent of this series) and when these have become so extensive as to merit cystectomy metastasis may almost be assumed to be present, reducing even cystectomy to the rank of a palliative operation.

#### CASE HISTORIES

CASE 1. Grade II. Ch. male, 72 years old, had had symptoms 2 years. He was operated upon in February 1926, 5 radons of 2 milllicuries each being implanted. Last cystoscopy was done in September 1927. He was last heard from in September 1932; he had been well, 6½ years after operation.

CASE 2. Grade III. Ma., male, 74 years old, had had symptoms 6 weeks. He had multiple tumors, and had been operated upon in April, 1927. Twenty radons of 1.5 milllicuries each were implanted. He was well in September 1932, 5½ years after operation.

CASE 3. Papilloma. Sch. male, 64 years old, had multiple tumors, and was operated upon in December 1926. Twenty 1 milllicurie radons were implanted. Last cystoscopy was done in February 1933. He has remained well 6 years after operation.

CASE 4. (Not graded) Cr., female, 81 years old. The bladder was resected for tumor in 1918. In 1922 and the following years fulguration and cystoscopic radium implantation were administered. She came to me in 1926 with a small, soft, papillary tumor about the right ureteral orifice. After several months of vain cystoscopic efforts, in August, 1926, the bladder was opened and 5 radons containing .5 milllicuries each were implanted. She was a difficult patient. The tumor reappeared in October 1927. In spite of cystoscopic treatments the growth spread over the bladder and in January 1930, she died of carcinoma, almost 5½ years after the operation.

CASE 5. Grade I. Mo., male, 50 years old, had had symptoms 1 year. An extensive growth was present in the bladder and posterior urethra. Operation was done in December

1926. Eleven 1 millicurie radons were implanted. A small recurrence was fulgurated 3½ years after operation. Six months later active pulmonary tuberculosis appeared she had lost 10 pounds. Last cystoscopy was done in May 1933. No tumor was present. Patient was well and tuberculosis had been controlled.

CASE 6. Grade I. Ro., male, 55 years old, had had symptoms one year. He had extensive multiple tumors. Operation was done in October 1926. Eleven radons of 1.5 millicuries each were implanted. Numerous postoperative fulgurations were applied to five distinct recurring tumors, one of them within the urethra. The recurring bladder tumors were cleared up by November 1929 but the urethral tumor persisted. Four hundred millicurie hours of radium emanation in a catheter tied in the urethra (125 millicuries) in August 1930 partially controlled this and a month later it was destroyed by fulguration. November 1929 a recurrent bladder tumor was burned off and in April, 1930 the bladder and urethral tumors were again burned. In October 1931 a one stage suprapubic prostatectomy was done the fistula was closed in 14 days. In continence of a few drops of urine followed operation and persisted. In December, 1933, cardiac decompensation prohibited his getting about. Last cystoscopy was done in November 1933 but no tumor was found. Patient was last seen in May 1933, and was completely inactive because of heart but he empties bladder holds urine 2 to 4 hours, has no symptoms of tumor 3½ years after operation and 3 years after the last cystoscopic treatment.

CASE 7. Grade III. On., female, 76 years old. Operative death.

CASE 8. Not graded. Gr. female, 67 years old, had a tumor of the lower end of the ureter and bladder following nephrectomy for papillary carcinoma of kidney pelvis. Cystoscopic treatment failed. Operation was done in July 1926. Twelve 1.5 millicurie radons were implanted. No postoperative treatments were given. Cystoscopy 17 months after operation was negative. She was last seen well 6½ years after operation.

CASE 9. Grade III. Schw. male, 55 years old, had had symptoms 7 months. Operation was done in May 1927. Fifteen 1.5 millicurie radons were implanted. No postoperative treatments were given. Cystoscopy was negative and patient was well in November, 1932 5½ years after operation when he was 60 years of age.

CASE 10. Not graded. Bul., male, 60 years old, had had symptoms 6 months. Operation was done in November 1926. Fourteen 1.5 millicurie radons were implanted. No postoperative treatment was given. Last cystoscopy was done 4 years after operation. He was well 6 years after operation, November 1932.

CASE 11. Grade II. Ca., male, 48 years old, had a tumor of the bladder and urethra, with symptoms for 7 months. Cystoscopic treatment irritated the bladder. Operation was done in November, 1926. Fourteen 1.5 millicurie radons were implanted. The urethral tumors were fulgurated in May 1927. There was an arteriosclerotic bladder ulcer (post radium) in March 1928, but no tumor. He was well in December 1930, 4 years after operation.

CASE 12. Grade II. Ill. male, 40 years old had had symptoms 20 years, with tumors of bladder and urethra. He was operated upon in March, 1928. Twelve 1.5 millicurie radons were implanted. Patient was lost sight of after a negative cystoscopy in August, 1928.

CASE 13. Grade III. Por. female, 30 years old had had symptoms 1 year. She was operated upon in January 1926. The tumor was excised with cautery and 3 platinum radons of 3 millicuries each were placed in the base at least 3 centimeters apart. This was one of the first patients operated upon. It was recognized that the amount of radium was in

adequate but no more was at hand. Six weeks later cystoscopy was negative but in May a recurrence was seen and in June 3 radons of 1.5 millicurie each were implanted in this. Thereafter cystoscopy showed no tumor in September 1926 and September 1927. But in August, 1928, a carcinomatous lymph node appeared above the left clavicle and cystoscopy showed a deep carcinomatous ulceration to the right of the fundus. No treatment was given. She died in June, 1929 3½ years after operation.

CASE 14. Grade III. Ba. male, 54 years old had had symptoms 6 months. Cystoscopic treatment failed. He was operated upon in December 1926 when 20 gold radons 1 millicurie each, were implanted. Three months later cystoscopy showed tumor and 13 radons of 1.5 millicurie each were implanted (operation) into the same growth. Cystoscopy was negative in 1930. He was last heard from alive and well in January 1933, 6 years after operation.

CASE 15. Grade II. Pa. male 54 years old, had had symptoms 3 months. He was treated first in September 1925, by suprapubic section and implantation of 6 steel tubes each containing 3 millicuries of radium element. A recurrence at the same spot was controlled by implantation through the cystoscope in December 1925 of 3 platinum radons containing 3 millicuries each followed by 5 fulgurations in the next 3 months.

The bladder growth thereafter remained healed but in October 1926, a urethral neoplasm appeared and this, in spite of many fulgurations and the urethrosopic implantation of one 1.5 millicurie radon in February 1927 and three 1.5 millicurie radons in September of the same year continued to grow and extended to the prostate, the patient dying in September 1930, of secondary carcinoma of the prostate, 5 years after his operation.

CASE 16. Grade II. Fra. male 44 years old, had had symptoms 15 months. He was first treated in November 1925 by the implantation of 10 tubes, each containing 2.5 millicuries of radium element. Tumor was uncontrolled. In October 1926 fifteen radons of 1.5 millicurie each were implanted in January, 1927 five more by cystoscope and in February 1927 the bladder was reopened and twenty five 1 millicurie radons implanted. This resulted in severe radium burn and caused a vesicorectal fistula but did not control the carcinoma of which he died in June 1929 3½ years after the first operation.

CASE 17. Grade III. Po., male 47 years old had had symptoms 18 months. He died in spite of much fulguration, 3 suprapubic implantations of radium (the first with glass seeds) and a resection of the bladder vault. Death was due to ileus after resection of the bladder but carcinoma of the bladder was found in the specimen and postmortem no metastasis was found. Treatment was begun in February 1924, the patient died in May 1927.

#### CLINICALLY INFILTRATING TUMORS

CASE 18. Grade III. Buc. male 54 years old, had had a carcinoma of larynx 2 years previously and 18 months before operation hematuria with diagnosis of carcinomatous ulcer. He refused operation until February 1926 when 6 platinum radons containing 1.5 millicuries each were implanted in an extensive tumor covering the trigone and left bladder wall, its base about 6 by 8 centimeters in diameter. This implantation was obviously inadequate. The patient died of carcinoma 9 months later.

CASE 19. Grade III. Bird. male 44 years old, had had symptoms 4 months. In February 1928, operation revealed a carcinomatous ulcer of the base of the bladder 6 by 3 centimeters. Thirty gold 1 millicurie radons were implanted in two layers. Patient died of carcinoma in 5 months.

CASE 20. Grade III. St. Jo., male, 56 years old, had had symptoms for 4 years. Operation in September 1926 dis-

closed an infiltrating papillary growth, its base 3 centimeters in diameter extending from above the urethra to the vertex. The infiltration was at least 1 centimeter thick, the projecting tumor of considerable size. Fifteen 1.5 millicurie gold radons were implanted. This was inadequate. He considered himself well until March, 1937 when his symptoms recurred. I refused to re-operate upon him. He was re-operated upon elsewhere and more radons were implanted. He died in June, 1937 9 months after the first operation.

**CASE 19.** Grade IV. Scha, male, 59 years old, had had symptoms 7 months. Operation was done in September 1937. Five gold 5 millicurie radons were implanted into the indurated base of a small papillary tumor situated near the right ureteral orifice. The bladder lesion was controlled but the tumor extended into the pelvis and in April, 1938, months after operation, patient died of carcinoma.

**CASE 20.** Not graded. Te, male, 66 years old, had had symptoms 4 years. The bladder tumors had been fulgurated. In October 1936, operation was done and revealed an infiltrating tumor surrounding the bladder neck and occupying the trigone. Twenty gold 1.5 millicurie radons were implanted. In January 1937 3 months after operation, patient died of carcinoma.

**CASE 21.** Grade III. Bier, female, 50 years old, had diabetes, with symptoms of bladder tumor for 6 months. September 1936, operation revealed a hard infiltration extending from the vertex down the right side to the base. The perivesical fat was sclerotic. The lesion was 3 centimeters wide and about 5 centimeters long. There were several secondary tumors. Fifteen gold 5 millicurie radons were implanted, but without benefit. In April, 1937 7 months after operation, she died of carcinoma.

**CASE 22.** Not graded. Du, male, 7 years old, had had symptoms 5 months. In November 1937 operation revealed a tumor of the left side of the base of the bladder. Its base 3 by 3 centimeters in diameter. Twenty gold 1.5 millicurie radons were implanted. The bladder symptoms were controlled but pains developed 3 months later in the left side of the pelvis, to and in March, 1939, 6 months after operation, patient died of carcinoma.

**CASE 23.** Grade IV. De, female, 70 years old, had had symptoms one year. In February 1938, operation revealed an ulcerating, infiltrating, papillary tumor of the vault covering the major part of the right wall of the bladder. Thirty 1.5 millicurie radons were implanted, but were evidently inadequate. In May 1938, 4 5 millicurie radons were implanted by cystoscope and in March, 1939, 3 months after operation, she died of carcinoma.

**CASE 24.** Grade III. Fa, male, 67 years old, had had symptoms 3 or 4 years. In January 1937 operation was performed. First the peritoneum was opened and it was found that the whole subperitoneal portion of the bladder was infiltrated with carcinoma, the tumor having originally doubtless been in the vault. Twenty gold millicurie radons were implanted into the bladder from its peritoneal surface without opening the vascus. A month later a radionogram showed only 3 radons. The other had doubtless been pushed through the bladder wall and been lost. Accordingly the bladder was opened and 50 gold millicurie radons were implanted. These were evidently inadequate but the immediate result was surprisingly good. Before the second operation he had lost 31 pounds. He regained 21 of these and in November 1937 the cystoscope showed a much inflamed contracted bladder with an ulcer in the fundus but no definite tumor. He died of carcinoma without recurrence of his grave bladder symptoms in July 1938, 8 months after operation.

**CASE 25.** Not graded. Fl, male, 64 years old, had had symptoms 5 months. In February 1937 operation re-

vealed an extensive infiltrating carcinoma of the left side of the bladder extending from the trigone half way to the apex. Seventeen gold 1 millicurie radons were implanted. The operation gave no relief whatever. In January 1938, 11 months after operation, he died of carcinoma.

**CASE 26.** Grade III. Ge, male, 63 years old, had had symptoms about 1 month. In February 1936, a tumor about 4 by 4 centimeters in diameter at its infiltrated base was implanted with 3 platinum 2.5 millicurie radons. Radiation was inadequate. The symptoms were relieved for a year. In May 1938, 27 months after operation, patient died of carcinoma.

**CASE 27.** Grade II. (See text.)

**CASE 28.** Not graded. Bo, male, 43 years old, alcoholic, syphilitic, had had symptoms of bladder tumor for 6 months. He arrived at the hospital suffering with retention due to clots. In March, 1937, operation revealed an ulcerating tumor of the right side of the bladder neck and edge of trigone, its base infiltrated and 3 by 4 centimeters in diameter. Thirty-two platinum 1 millicurie radons were implanted partly in two layers. An ischiorectal abscess resulted and never healed. In August, 1937, cystoscopic examination showed a granulating area in the region of the right ureter a specimen from which was reported carcinoma. Accordingly in October 1937 operation and implantation of 9 gold 5 millicurie radons were done. In March, 1938, suprapubic extravasation of urine was opened. In May 1938, urination was painless, he had gained pounds. He was urinating once at night and every 3 to 4 hours by day but was still drinking heavily. In June, 1939, the local condition remained about the same. He was developing an alcoholic blindness and was overwhelmed with debt. He committed suicide.

**CASE 29.** Grade IV. Sm, male, 5 years old, had a perineal prostaticectomy 1 year before for relief of hematuria. Operation had been successful. The cystoscope showed a tumor to the right side of bladder neck. In June, 1936, 6 gold 5 millicurie radons were implanted in an infiltration 3 by 3 centimeters on the upper quadrant of the right side of the bladder neck. In September 1936, the cystoscope showed several masses of tumor in this same region. The bladder was again opened and 7 gold 1.5 millicurie radons were implanted. In October 1936, the cystoscope showed one lesion persisting and through the cystoscope 4 gold millicurie radons were implanted. Thereafter patient remained well and free from symptoms and at work until the spring of 1932 when his bladder symptoms recurred, his pelvis was found full of carcinoma, and he died in August, 1932, of carcinoma, 6 years after his operation.

#### SUMMARY AND CONCLUSIONS

1. The American Urological Association Registry amply justifies its existence. It gives a sound basis for comparison between case reports and a sound measure of progress in our therapy.

2. All epithelial tumors of the bladder graded as I or II should be attacked as curable by fulguration, radon implantation or cystectomy unless moribund or inoperable for other reasons.

3. Grade III has a bad prognosis. We can report but 23 per cent 5 year control. Most of the cancer deaths occur in the first two years.

4. The prognosis of grade IV is even worse. Yet one patient has remained at work and

apparently well for 6 years—and then died of cancer

5 No attempt has been made to compare cystoscopic fulguration or radon implantation with suprapubic radon implantation. During the period within which these 31 patients were operated upon 6 patients were seen who were deemed too far gone for operation and radons were implanted through the cystoscope into 7 others—and cystoscopic fulguration was sufficient to cure "about a dozen" others (for these I have no exact figures). Thus during this period more than half my bladder tumor patients submitted to suprapubic implantation of radons. Thanks to the practice of suturing the bladder without drainage the postoperative mortality and discomfort are slight. Thirty seven radon implantations are here reported with but one postoperative death. (The second postoperative death followed resection of the bladder.) The atrocious postoperative spasms that follow the implantation of glass seeds do not occur. Twenty seven of the operations were followed by no more discomfort than is to be expected after any cystotomy. The 6 patients who required more than one operation submitted to the second operation without comment.

6 Comparison between resection of the bladder and radon implantation for the treatment of the more malignant tumors cannot be attempted

on the basis of the cases reported here. Cure of a localized tumor is possible by either method. Resection is not applicable to tumors about the trigone or bladder neck, though these present no peculiar difficulties to radon implantation. Ureteral reimplantation does not have to be considered. The operative mortality is much lower, the stay in hospital so much shorter as to pay for the radium. (In this series 11 were drained and of the 26 sutured without drainage, 11 broke open. For the 15 who did not leak the average postoperative stay in hospital was 15 days, for the others the postoperative fistula stayed open on an average of 23 days.) It is to be hoped that the durability of radium cure is no longer questioned. I have reported 2 patients relieved for over 10 years.<sup>1</sup>

7 At the other limit of malignancy, in the treatment of tumors of grades I or II, the high frequency current competes with radium for use by suprapubic section just as it does for cystoscopic use. Indeed the current offers the most convenient method of removing the growth preliminary to implantation. For the treatment of minor degrees of malignancy the choice is perhaps of no great importance. But whether applied through the cystoscope or through the suprapubic wound, radium destroys malignant tumors that fulguration does not control.

Sarg. Gynec. & Obst. 1933 Vol. 46:2-263.



Application of heat in the vagina for varying periods has been one of the principal factors in conservative treatment. Its use in some form has been increasing progressively. Early medical records refer to the hot vaginal douche as a cleansing agent used for the relief of pelvic pain. Also German physicians heated shot and poured them into the vagina in order to maintain heat for a prolonged period. The therapeutic effect of prolonged and sustained heat, applied by vaginal douche, was enhanced by the observation of Gellhorn that the mucous membrane of the vagina could tolerate much higher temperatures than the skin of the perineum and vulva.

Realizing the marked beneficial effect of heat in inflammatory disease of the pelvis, efforts were directed toward perfecting methods by which heat could be automatically varied according to the tolerance of the patient and the severity of the inflammatory disease. First among these methods of applying heat was the medical diathermy current, and later the Elliott technique. Medical diathermy has been and still is, used rather extensively with beneficial results. Cherry was able to obtain either cure or improvement in 72 per cent of cases in which the temperature varied from 104 to 122 degrees F. These results have been duplicated and confirmed by Scheffey and Schmidt, Gellhorn and Bettman and Crohn. Use of the procedure was somewhat limited however on account of the costliness of the apparatus; furthermore considerable knowledge of the diathermic current was essential. This led to a desire for a simplification of technique and to one by which heat, when applied in the vagina, would be radiated in all directions, over a greater surface area. The method devised by Elliott satisfied these requirements. Its principal advantage over preceding methods is that the heat is derived from a current

of hot water which is circulated through a soft, distensible rubber bag which, when applied, fits snugly around the cervix. The pressure and temperature of the water within the bag are controlled by an electric motor and thermostat. In the average case, the treatment is begun with the temperature of the water about 110 degrees F and this is gradually increased to 130 degrees F depending on the patient's tolerance. Daily treatments lasting half an hour to one hour are given as a routine. From ten to fourteen treatments meet the average requirements in most cases.

The therapeutic effect of the heat is shown by marked hyperemia in the pelvic tissues, increase in leucocytosis, profuse discharge from the cervix and vagina, and gradual decrease in pelvic pain. At a temperature of 130 degrees F for one hour the temperature in the vagina, uterus, rectum, bladder and pelvic peritoneal cavity is increased 5 to 7 degrees F without any disturbance in the general temperature of the body.

The rapidity with which induration in the broad ligaments and often fluctuation in the cul-de-sac and adnexal regions, disappear following a few treatments with sustained high temperatures often is remarkable. Cases in which previously surgical intervention would have been considered are definitely removed from the group of surgical cases. Of 23 cases of pelvic abscess reported by Holden and Gurnee in only 3 cases was drainage required following treatment by the Elliott technique. Furthermore, when heat was used as a pre-operative measure, the extent of operative interference necessary was considerably reduced and the amount of tissue conserved was increased.

At The Mayo Clinic a study recently was made on a series of cases in which infections of the pelvis were chronic, and in which the

Elliott principle of application of heat was used. The treatment was used both as a pre-operative and as a postoperative measure. Clinical cures were obtained in 70-83 per cent of the cases in which surgical procedures were not employed, whereas the postoperative benefits, such as the shortened period of convalescence, the rapid absorption of exudates, and the reduction in morbidity, were classified as excellent in 100 per cent. Furthermore the treatment served as an invaluable aid in separating the definitely surgical cases from cases in which clinical cure could be achieved by

conservative measures. Also, in a high percentage of cases that were persistently refractory to conservative treatment other pelvic pathologic changes, such as myomas, cysts, and teratomas were associated.

It is to be hoped that these results, and similar results reported by others, will help to bring about a greater degree of conservatism in the treatment of pelvic inflammatory disease and thus contribute to a lower mortality rate, reduction in morbidity, and conservation of pelvic organs, especially of young adult women.

VIRGIL S. COUNSELLER.

# MASTER SURGEONS OF AMERICA

DAVID PRINCE

**I**T is altogether worth while to pause occasionally and think of the pioneers who hewed and wrought in this great Mississippi Valley. What was the American Dream which possessed them to cross the mountains, undergo the hardships and dangers of building a new country on new ideals? This great West is ample evidence of how well that dream has come true.

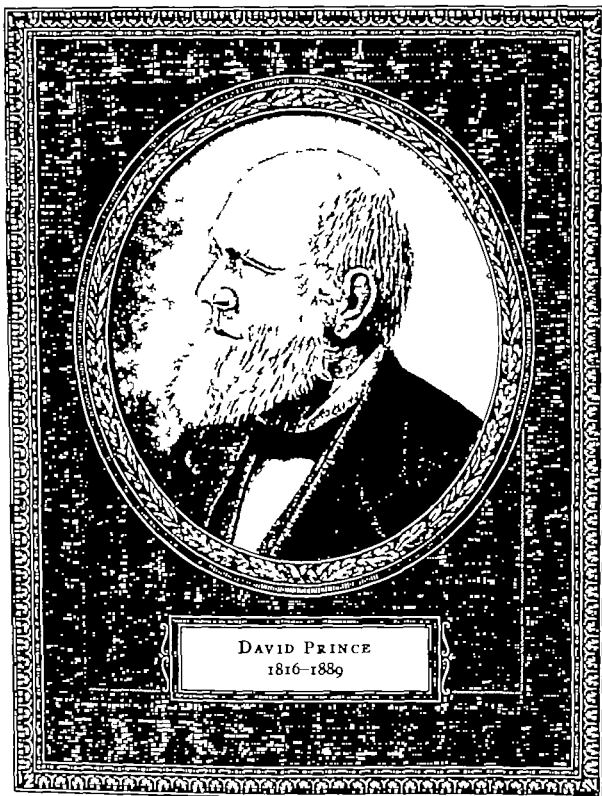
David Prince belonged to one of those families of New Englanders that dreamed and went west to Illinois. Born in Brooklyn, Connecticut, June 21 1816, educated at the Canandaigua Academy in New York, and with one year's study of medicine at the College of Physicians and Surgeons in New York City he journeyed to Cincinnati, Ohio. He spent one year at the Ohio Medical College and graduated probably in 1838.

A most fortunate incident of his life was his association for a year and a half with Dr. Reuben D. Mussey of Cincinnati. Dr. Mussey also a New Englander had been a teacher of surgery at Dartmouth and Bowdoin before coming west. Before graduating at the University of Pennsylvania in 1809 Mussey had done a piece of original research which disproved the theory that the skin had no power of absorption. He was the first to show that an intra capsular fracture of the hip could make bony union, the first to ligate both common carotid arteries, and the first (1837) to remove both the scapula and clavicle for sarcoma of the upper arm.

Thus David Prince was thrown at once under the influence and inspiration of one of America's great surgeons and teachers. That he improved this opportunity is amply demonstrated by his future career.

While in Cincinnati Prince became acquainted with Samuel D. Gross, who was teaching in another medical school there. This acquaintance continued and is attested by Gross's warm words of appreciation of the writings of Prince in the fields of plastics and of orthopedics.

About 1840 Prince followed his family to Iayson, Adams County, Illinois, where he practiced medicine and surgery for three years. In 1843 Illinois College added the department of medicine to its course, and David Prince was called to the chair of anatomy and surgery. Thus he became the first teacher of surgery in a medical college in Illinois.



DAVID PRINCE  
1816-1889





Jacksonville Sanitarium, David Prince's private hospital,  
1865-1889.

When this school was discontinued in 1848 he moved to St. Louis, and lectured on surgery at the St. Louis Medical College. Here he formed a life long friendship for Dr. John T. Hodgen, another of the great pioneer surgeons of the Mississippi Valley.

In 1852 Doctor Prince returned to Jacksonville, Illinois, and took up the independent practice of surgery. During the Civil War he served as brigade surgeon in the Army of the Potomac. When his men were captured and sent to Libby Prison, he voluntarily went with them. After the war he was in the office of the Surgeon General for a year assisting in the preparation of the medical and surgical history of the Army of the Potomac.

In 1866 he opened a private hospital in Jacksonville in order to provide facilities for his surgical patients.

Doctor Prince twice read papers before the International Medical Congress, once in Copenhagen and once in London. He was at least twice a medical visitor and student in the hospitals and clinics of London, Glasgow, Paris, and Berlin.

The diaries he kept during the Civil War and on his trips abroad well illustrate his studious habits. Nothing escaped him. His visit to Paris in 1884 was at the time the French were attempting to prove that surgical infection was due to the micro-organisms in the air. After his return home he built an elaborate operating room in which all the air was filtered through many layers of cotton before it reached the field of operation. While such operating rooms represented an advance in surgical thought regarding infection, contact infection soon captured the field and gave the air borne theory a subordinate position.

David Prince was short in stature, heavy in body, with a large head and an open countenance. He had little to say. He kept his thoughts and plans to

himself until they were really needed and then he described and explained them in few words. On the other hand, he was a man of wide reading and wide interests. Everything in the community, state, and county attracted his interest. He read German and French and had a good acquaintance with Latin. His surgical methods were truly Hunterian. He always maintained a dissecting room and worked in it. Every new operation was worked out on a cadaver. He always had the courage of his convictions but was blunt and far from diplomatic in their statement and execution. This trait no doubt had something to do with prematurely closing the Illinois College Medical School. It was the anatomy question. He believed every student should understand anatomy. Dissecting material had to be supplied—law or no law—and he supplied it whether the community liked it or not.

While in St. Louis he had as a room mate a former Illinois College Medical student, Dr. Samuel Willard. Willard wrote me that "in 1850 Prince received an English Medical Journal mailed to him from England. He scanned its pages then tossed it aside saying 'I don't see why anybody sent me that.' I took it up and found a short article giving the names of ten surgeons who had up to that time successfully removed ovarian tumors. The name of David Prince was among them. It was characteristic of him to try everything new. He was among the first in Illinois to use ether as an anæsthetic."

When preceptors were the order of the day he was preceptor to many prospective doctors. Central Illinois was dotted over with physicians who had studied with Prince and were proud of it. He always had from one to six students about his offices. He took an active interest in them and supervised their study but never accepted a fee for such service.

He was an active member of and a contributor to many medical societies. He wrote and published numerous medical papers. He was one of the early members of the American Medical Association, the Illinois State Medical Society and the American Surgical Association, and he was the author of several books among which we list the following: *Orthopedics, a Systematic Treatise upon the Prevention and Correction of Deformities* (1866), *Plastics, a New Classification and a Brief Exposition of Plastic Surgery* (1868), *Plastics and Orthopedics* (1871), and *Galvano-Therapeutics* (1874). All were published by Lindsey and Blakiston.

Doctor Prince was twice married. First to Mary J. Dawson and two years after her death to Lucy M. Chandler. He had two sons, both surgeons, and one daughter who married a physician. He died of pneumonia December 19, 1889.

CARL E. BLACK.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

A UNIQUE monograph<sup>1</sup> by Rothrock records his private practice during the last ten years. It is a careful report of 1750 pregnancies and 1345 gynecological operations, among the author's private patients and is an excellent object lesson in the desirability of keeping accurate case records.

The author follows the conservative obstetrics and gynecology of the present day and the reader must therefore agree with practically every procedure as outlined. Added to this fact is the unusual method of presentation namely a volume of case reports. This combination makes the book most interesting and instructive.

"That nature is kindly disposed to the expectant mother of the poorer class as her offspring are usually smaller at birth is not universal. In many of the larger institutions the clinic babies are larger than those in private practice. The difference is due to racial stocks and to geographic distribution rather than to the financial status of the patients. Furthermore the preponderance of multiparae in clinic practice will tend to produce larger babies than will the preponderance of primiparae and secundiparae of private practice.

Rothrock uses only rupture of the membranes and the Voorhes bag for the induction of labor. Stripping the membranes and castor oil with or without small doses of pituitrin is such a simple and effective method of induction of labor at or near term, that it is rather surprising that the author does not avail himself of this procedure.

Following delivery under anesthesia, the patient is allowed to wake up and after delivery of the placenta perineal repairs are done under local infiltration anesthesia. This would seem to be unnecessary. Recent investigations all tend to show that the placental separation occurs more promptly following delivery than was formerly believed. Perineal removal and perineal repairs can thus be included in the anesthesia of delivery thus obviating undue delay or prolonged anesthesia.

It is pleasing to see that the author does not hesitate to use "properly carried out vaginal examinations, whenever indicated and that he sees no difference in the resultant morbidity. In a discussion of this latter the author describes "54 cases that ran a febrile course. A morbidity of 3.1 per cent is enviable. For the purpose of comparative

TEN YEARS OF OBSTETRICS AND GYNECOLOGY IN PRIVATE PRACTICE; A CLINICAL REPORT OF 1750 OBSTETRICAL AND 1345 GYNECOLOGICAL CASES, WITH COMPARATIVE ANALYSES OF MANY OF THE LARGER GROUPS, AND DETAILED CASE HISTORIES OF SOME OF THE MORE IMPORTANT AND LESS COMMON CONDITIONS. By John L. Rothrock, A.B. M.D. F.A.C.S. New York: Paul B. Hoeber Inc., 913.

studies it would have been most helpful if the author's standard of morbidity had been described the phrase used being so indefinite that comparisons cannot be made.

The second half of the book deals with gynecology. The procedures described are those in common use in this country with only occasional variations such as for the correction of uterine retrodisplacement. The author is to be complimented on his results, his low morbidity and mortality and for the careful follow up of so large a number of patients.

RALPH A. REIS.

LIGHT therapy has been a source of bewildering and hastily written literature. Krusen has rendered the medical profession a real service in bringing to them in his book<sup>2</sup> a clear and concise presentation of the facts of this controversial subject.

The physics of light therapy is most important and it is given here so that a physician with but an elementary knowledge of physics can readily understand it. The sources of therapeutic radiation used today are considered. The physiological effects and the technique of the application of radiant energy are thoroughly discussed.

There are ten concise chapters dealing with the use of ultraviolet radiation in the various diseases amenable to this form of therapy. The author does not make exaggerated claims for the efficacy of ultraviolet therapy and advises physicians to read critically the mass of medical literature on the subject and to evaluate such articles on the basis of definitely established facts. As it is impossible for one individual properly to evaluate these claims in so many diverse branches of medicine the author gives references to original articles and suggests that the student interested in some special subject go to the original sources and investigate the claims for himself.

The book is admirably printed well illustrated and scientific and concise in its presentation. It is therefore recommended as a valuable book for every physician medical student and technician interested in light therapy. JOHN S. COULTER.

THIS second revised edition of Buckstein's contribution to the *Annals of Roentgenology* contains much of the same material found in the first edition.

LIGHT THERAPY. By Frank Harwood Krusen, M.D. Foreword by John A. Kober, M.D. Dr. F.H., D.Sc., LL.D. New York: Paul B. Hoeber Inc. 913.

ANNALS OF ROENTGENOLOGY: A SERIES OF MONOGRAPHIC ARTICLES. Edited by J. Edgar T. Case, M.D. VOL. 2, PEPTIC ULCER. By J. Cobb Buckstein, M.D. 2d ed. New York: Paul B. Hoeber Inc. 913.



with the addition of many new things of great value. The roentgenograms show gastric and duodenal lesions of all types and in almost all stages of development and regression. The effect of treatment and the recession of the ulcer, when it responds to treatment, are well shown. The great value of mucous membrane studies and their relation to ulcers of the duodenum and posterior wall of the stomach is stressed.

In the opinion of the reviewer however while the didactic matter is up to date and shows that the author is cognizant of the recent literature, it is so sketchy that, in a book of this size it should have been either amplified or dropped entirely. The descriptions of the plates are too brief to be of value to the inexperienced and to the experienced interpreter of roentgenograms the films are of such dubious quality that one must of necessity be well versed in the study of roentgenograms to interpret them. It is difficult to understand why all the illustrations are direct prints from X ray films, thus giving color contrasts opposite to that viewed by the radiologist on the ground glass screen.

The discussion of mucous membrane relief studies is of considerable interest and the illustrations merit favorable comment. The second edition elaborates somewhat on this type of examination and the pathological anatomy of the mucous membrane.

Finally it seems to me that the book is entirely too large for the matter contained. I believe it could be cut down to two-thirds its present size without detracting from the value. This probably would be reflected in a lowered cost.

ROBERT A. ANDER.

**VOLUME VII** which is a supplement to the *System of Operative Surgery* by Bickham appears now approximately 8 years after the publication of the original work. In this volume which is prepared by Smyth, the author endeavors "to bring up-to-date the previous six volumes by the addition to each section of those operative procedures which have become established as a part of the armamentarium of the well equipped surgeon.

After a rather fruitless attempt to extol the art and science of surgery the author describes operations which he believes should be included in a complete system of operative surgery and which are not to be found in the six volumes originally published. The author makes no claim for originality of the operations and in practically every instance quotes extensively from, and gives credit to, the originator of the technique discussed. The chapters dealing with operations upon the chest and the colon contain the greatest amount of new material, since it is the author's belief that in these fields the greatest number of new operations has been developed in recent years.

**OPERATIVE SURGERY: THE OPERATIVE TECHNIC INVOLVED IN THE OPERATIONS OF GENERAL AND SPECIAL SURGERY.** By WALTER SCOTT BICKHAM, M.D. First Edition. M.D. (Columbia), F.A.C.S., and CAROL MARY SMYTH, Jr. B.S., M.D., F.A.C.S. Vol. vii. Philadelphia and London: W. B. Saunders Company 1931.

The volume is replete with excellent illustrations depicting operative technique and as a whole the material is well assembled, yet this work seems to lack the scientific and classic flavor of the previous volumes. The text is at times misleading and difficult to construe. An exception must be taken to the statement on page 81 relative to precautions to be observed in using spinal anesthesia. The author states that "If the systolic pressure drops to 30 mm Hg., give an intravenous injection of warm physiologic salt solution or Ringer's solution, and if the pressure continues to drop epinephrine should be added in sufficient amount to bring the systolic pressure to 40."

Such advice if taken literally would lead to frequent disasters. On page 240 the author states that in draining the floor of the mouth an incision is made "between the hyoid bone and the thyroid cartilage"—obviously an error also that a haemostat when passed into the incision will appear between the teeth. Attention is called to these items in an effort to give a constructive criticism of the work since it is obvious that a tremendous amount of energy has been expended in the preparation of the volume. The author has attempted to place in the hands of the reader a ready means to familiarize himself with a countless number of established operative procedures but the reader at times is handicapped in that statements are sometimes involved and a few errors have crept in.

JOHN A. WORMA.

**THE** announcement of a work upon the treatment of squint from one of the English clinics where so much interesting work has recently been done was received in this country with the highest expectations. Miss Dobson's little book fails to live up to these in many respects. The chapters on binocular vision and binocular balance are necessarily short and offer nothing new but contain a useful résumé of some practical tests. The author emphasizes the suspension of vision as a cause of squint and discusses the importance of its recognition and treatment by orthoptic training at the earliest possible moment. Miss Dobson believes that while amblyopia may be congenital, in which case treatment is of no effect, amblyopia from disease does often occur and is susceptible of great improvement by treatment. Besides the usual measures, the use of monocular stimulation by moving objects with an American instrument, the myoculator and with the author's rotating disc is advised. It is interesting that Miss Dobson employed a modern form of the "squint mask" illustrated in the oldest texts. Rubber discs are worn, provided with holes which limit the field of the fixing eye and admit light to the amblyopic eye at a point away from the amblyopic area in which vision is suspended. The stimulation of these seeing areas develops vision and causes the position of the eye to improve.

**STRABISMUS VISION: OR THE MODERN TREATMENT OF SQUINT.** By MARGARET DOBSON, M.D. (London). London: Oxford University Press, 1931.

markedly she claims. Other devices making use of the same principle are employed with much ingenuity.

One is surprised to find a discussion of refraction in this book, and is more surprised that the author is a warm advocate of "dynamic refraction," giving atropine, apparently in very few cases. Few ophthalmologists will agree that all the latent hyperopia can be elicited by this means, or that correcting only a portion of this will make the fullest possible use of refraction in correcting convergent squint.

The discussion of orthoptic training comprises 40 pages and consists chiefly in a description of various ingenious instruments which have recently been devised by Maddox and other English workers. Most important of these are the synoptoscope and the author's binocularscope.

Your reviewer believes that Miss Dobson is right in stressing the importance of orthoptic training in most cases of squint and that such training is equally important after operation where this becomes necessary. What she fails to do however is to prove her thesis by illustrative cases or by statistics of results in a group of cases. She is content with general statements that this or that procedure will cure many cases of squint or improve amblyopia. No statistics of other workers are quoted and her bibliography consists in large part of references to the announcements of instrument makers. Works by a "Dr. Peckham of Waterbury, Connecticut" who would seem to be an optometrist, are quoted with respect.

Miss Dobson apparently fails to realize that many

excellent ophthalmologists have been discouraged in the use of orthoptic training by their own experience or by the reports of others, and that a great deal of real evidence is required to convince them of its importance.

SANFORD R. GIFFORD

THE monograph on the combined procedures of "arteriography and encephalography" by Loehr and Jacobi is published as a supplementary volume to Grashey's work on roentgen rays.

In it the authors present a review of the literature on encephalography and in more detail the literature on arteriography. A chapter is devoted to the development and usage of thorotrast as a contrast medium. They present fully their technique of cerebral arteriography which in their hands has been marked with exceptionally few hazards of deleterious effects. The contra indications are the same as for encephalography alone.

The topographical anatomy of the normal cerebral vessels as shown by arteriography, with thorotrast is given and a case of deviation from the normal (hemangioma of the face and brain) is shown in contrast. Descriptions are given of the findings by the combined procedures in cases of taboparesis, epilepsy, arteriosclerosis, hydrocephalus and cerebral tumor. A considerable portion of the clinical part of the work is devoted to a rather complete atlas of X rays of the procedure in cases of tumor.

HALE HAVEN

<sup>1</sup> FORTSCHRITTE AUF DEM GEBIETE DER ROENTGENSTRALLEN. Edited by Prof. Dr. Grashey. Vol. 187: DIE KOMBINIERTEN ENZEPHAL-ARTERIOGRAPHIE. By Prof. Dr. W. Loehr and Prof. Dr. W. Jacobi. Leipzig: Georg Thieme, 1933.

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

NEUE DEUTSCHE CHIRURGIE. Edited by P. von Bruns. Edited by Erich Lexer. Vol. IV: DIE LUT UND FERTIGKEIT. By Dr. med. Siegfried Hoffmann. Stuttgart: Ferdinand Enke, 1933.

ATLAS OF PATHOLOGICAL ANATOMY. Issued under the direction of the Editorial Committee of the British Journal of Surgery. Compiled by E. K. Martin, M.S., F.R.C.S. Vol. I. Baltimore: William Wood and Company, 1933.

THE TEACHINGS OF PREVENTIVE MEDICINE IN EUROPE. By Carl Fraenkel, M.D. (Breslau) M.R.C.S. (Eng.) L.R.C.P. (Lond.) London: Oxford University Press, 1933.

BRAIN TUMORS IN THE THIRD VENTRICLE OF THE BRAIN. DIAGNOSIS AND TREATMENT. By Walter E. Dandy M.D. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1933.

DE VEMARUM OSTIOLIS 1603 OF HIERONYMUS FABRICIUS OF AQUAPENDENTE (1533?-1610). By K. J. Franklin, D.M. Springfield, Illinois, and Baltimore, Maryland: Charles C. Thomas, 1933.

AMERICA SELF-CONTAINED. By Samuel Crowther. Garden City New York: Doubleday Doran & Company Inc., 1933.

WILHELM CONRAD ROENTGEN AND THE EARLY HISTORY OF THE ROENTGEN RAYS. By Otto Glasser. With a Chapter "Personal Reminiscences of W. C. Roentgen" by Margret Boveri. Springfield, Illinois and Baltimore, Maryland: Charles C. Thomas, 1934.

# AMERICAN COLLEGE OF SURGEONS

## THE ORGANIZATION OF A TUMOR CLINIC IN A GENERAL HOSPITAL<sup>1</sup>

GEORGE T. PACK, M.D., New York  
The Memorial Hospital, New York City

THE neoplastic diseases have not had deserved attention in this age of medical specialization. Hospitals especially equipped for the treatment of tuberculosis, affections of the eye, bones and joints, maladies peculiar to women and children and communicable diseases have been established throughout the country. Yet most cancers are treated in ambulatory patients by general practitioners and in the wards of general hospitals. A disease which is inevitably fatal if untreated, should receive the best possible advantages of care by physicians skilled in its diagnosis and treatment. To attain this end, these patients should be segregated in separate wards and clinics, under the management of physicians well trained in this work. It is our belief that this problem can be best solved by the establishment of tumor clinics in general hospitals.

This statement seems to be substantiated by the rapid increase in the number of tumor clinics in general hospitals during the last decade. Dr. Cox, of the American Society for the Control of Cancer, states that in 1920 there were approximately fourteen such clinics in the United States. In the February, 1932 issue of SURGERY, GYNECOLOGY AND OBSTETRICS, a report was made by Dr. Greenough, then chairman of the Committee on the Treatment of Malignant Diseases, to the effect that the American College of Surgeons had approved 100 cancer clinics, recommended for approval 58 cancer clinics, and that 185 clinics were in the process of organization.

The committee of the American College of Surgeons on the Treatment of Malignant Diseases has classified the special facilities for the treatment of neoplastic diseases into four groups, as follows: (1) cancer institutes (2) cancer research laboratories (3) cancer hospitals (4) cancer clinics in general hospitals.

The cancer institute is the ideal solution as it includes a hospital organized and maintained solely for the diagnosis and treatment of cancer as well as adequate research laboratories manned by a staff of pathologists, physicians, chemists, and

bacteriologists. Such cancer institutes which unfortunately are few in number include the Huntington Memorial Hospital in Boston, the New York State Institute for the Study of Malignant Disease in Buffalo, the Cancer Institute of the City of New York, and the Memorial Hospital in New York City.

It is not feasible to care for all cancer patients in cancer institutes or cancer hospitals because these institutions must be situated in centers of large population. Geographical distances are too great in the United States to enable the transportation of cancer patients to and from these centers as is the practice in Sweden and France. It is obvious that for economic and social reasons, the needs of the average community are best met by the cancer clinic in a general hospital. Since only a relatively small number of patients suffering with cancer can be treated in cancer institutes and cancer hospitals, the general hospitals throughout the country have the serious responsibility of caring for the greater proportion of cancer cases. Burton J. Lee has said:

"An inspection of almost any large general hospital in the United States or Canada will disclose cancer patients indiscriminately scattered throughout the services of the hospital, some under the care of the surgeon, others in a general medical ward, pediatric or orthopedic ward, and not a few under the care of the roentgenologist or radiologist. Cancer is a major health problem which must be intelligently met by the boards of managers and medical staffs of the large general hospitals in this country. No such hospital today can be considered fully efficient unless a well organized cancer service exists within its doors.

The tumor clinic may well be organized according to the recommendations of the Committee on the Treatment of Malignant Diseases of the American College of Surgeons in their brochure "The Organization of Service for the Diagnosis and Treatment of Cancer: A Minimum Standard."

The department had better be known as a tumor clinic rather than as a cancer clinic, because many patients do not wish to be seen in an in-

<sup>1</sup>The model clinic, of which this article is written, is the Josephine Louise Tumor Clinic of the Paterson General Hospital, Paterson, New Jersey.

stitution labeled as a cancer hospital. The word 'cancer' should not be employed in contacts with patients, even though a tacit understanding exists as to the nature of the disease being treated.

There are certain mutual advantages in the utilization of the personnel and physical equipment of already existing hospitals for the organization of a tumor clinic, because these constitute established centers in which modern diagnostic and therapeutic procedures can be conducted. These hospitals have the personnel and equipment for this service, and are only lacking in a definite organization together with sufficient radium, a high voltage X-ray machine and a radium therapist necessary to attain this objective. Approved general hospitals have already established their reputation in the community and the tumor clinic will benefit by this credit. The affiliation of the tumor clinic with the general hospital is the most economical arrangement possible, as it enjoys the advantages of clinic quarters, hospital beds, interne and nursing staff.

The establishment of such a clinic in a general hospital offers many advantages to the patient with cancer. First, the diagnosis of the disease is made accurately and promptly. Treatment of the cancer is instituted without delay. Precancerous lesions are recognized and removed. No one physician has sufficient knowledge and experience in the treatment of neoplastic diseases of all organs to be independent of the opinions and aids of his medical confrères. Group judgments as to diagnoses and proposed plans of treatment are preferable as they are based on the agreements of surgeon, radiologist, pathologist, etc. The patient benefits by the knowledge, skill and experience of physicians who have devoted themselves to the diagnosis and treatment of this disease. Furthermore, the cancer clinic is equipped with special diagnostic and therapeutic facilities as well as a supply of radium which independent physicians can seldom afford. Another important service is daily nursing care for ambulatory patients at a minimal cost.

After the establishment of a tumor clinic in a community it will be observed that the delay between the onset of symptoms and the appearance of the patient in the clinic will noticeably decrease year by year. Early submission for diagnosis results in a higher percentage of cancer cures. This increase in the relative percentage of cases classified as early or operable may be attributed to the educational activities of the clinic, the awakening of public and personal interest in cancer prevention and treatment, the missionary efforts of patients who have been satisfactorily treated and

the co-operation of the physicians in the community.

Advanced inoperable cases are usually treated by radium or X-rays which are held in scepticism by some patients and considered as infallible curative measures by others. On this account, the prognosis should be explained to the relatives in the case of every advanced cancer accepted for treatment by the clinic, as well as the degree of palliation defined and these facts reiterated at succeeding visits so that the relatives will not be too optimistic during the palliative stage. All cancers are not curable and the services of the clinic are not limited to early or operable cases. Occasional cures are unexpectedly obtained in certain apparently hopeless cancers. It is the function of the clinic to offer palliative treatment, if possible, to all the unfortunate patients who fall in this category. In discussing this point, Robert Greenough said: "I believe that the palliative treatment given to advanced cases is often one of the ways in which the clinic establishes its efficiency in the minds of the physicians of the community."

The number of cancer clinics in any community depends largely on local needs and existing hospital facilities. This is a problem which cannot be decided by rule of thumb or gross population. There can never be too many diagnostic tumor clinics in any city but for cancer therapy it is more ideal and less expensive to have properly located treatment centers with adequate radium and X-ray facilities.

The tumor clinic in the general hospital should be autonomous. It should receive for treatment not only the patients with advanced incurable cancers referred to it from the surgical service and other departments in the hospital but should be privileged at least to see in consultation or to outline the treatment of every patient with a benign or malignant tumor. Although all members of the hospital staff recognize the great need and value of a cancer clinic in a general hospital, yet a few individual members at first may be unco-operative. This attitude is most frequently encountered in surgeons who will not always relinquish with good grace the opportunities of operating upon so called operable cancers of the cervix, tongue or lip and object to the transfer of these patients to the tumor clinic where they may be treated with radiation therapy instead. Surgeons should realize that the vast majority of cancers are best treated by surgery alone or in combination with radiation therapy. Radium is an adjunct to surgery and often requires surgical exposures for its accurate application. The surgeon therefore must

play a very important rôle in the conduct of the clinic. Very few surgeons have a good foundation in or knowledge of radiation therapy nor are they sufficiently versed to know the relative values of surgery and irradiation in all varieties of cancer. It is for this reason that the patients should be first seen in the tumor clinic where their treatment is outlined. The tumor clinic in some hospitals merely serves as a medium for consultations and follow up observations. Its services under this arrangement are optional and not obligatory. However any clinic so established will prove its worth in time and later be given more authority in the disposition of cancer cases. In the tumor clinics in general hospitals where consultation is voluntary rather than obligatory the surgeon who does not avail himself of the opportunity so afforded will soon be criticized because of the inevitable mistakes made in the diagnosis and methods of treatment.

All cancer patients discharged from the wards of the hospital are referred to the tumor clinic for follow-up observations. There can be no serious objection to this plan inasmuch as the other hospital services are seldom as interested, conscientious, and competent in the after-care of patients treated for cancer. The follow up visits on patients treated for cancer extend indefinitely, as long as the patient lives. These visits should be made at frequent intervals during the first 5 years and after this at intervals of 6 months to 1 year for the remainder of life. Only by such observations at intervals can the percentage of so called cures of cancer be determined for definite periods of survival.

The tumor clinic should afford arrangements in the out patient department for the daily care of ambulatory patients undergoing radium therapy. This clinic frequently referred to as the "clean-up" clinic is under the management of a well trained nurse assigned to the cancer unit or in some instances to a junior attending surgeon. The skin reactions following radiation therapy of cancer of the breast, neck, or mouth are often intense and attended by blistering and desquamation of the skin causing the necessity for frequent or daily dressings. Patients under treatment for cancer of the mouth require frequent intra-oral irrigations and skilled cleansing of the mouth and of the cancer. This very important service greatly relieves pain and discomfort, lessens the danger of complicating infection, establishes adequate drainage for cavities (e.g., the paranasal sinuses) stimulates the production of granulation tissue in the healing of the wound, and invariably hastens the rapid recovery of the patient.

The establishment of the tumor clinic will reduce materially the amount of bed care in the hospital because many of the patients seen in the cancer clinic are ambulatory during the greater part of their treatments, whereas previously many of them were admitted to the hospital for the entire time. The tumor clinic therefore enables the general hospital to discharge its obligations to cancer patients by more accurate and scientific treatment given at less cost to the institution.

The expenses of the cancer clinic may be partially defrayed by charging those patients who are able to pay a small registration fee on application. There should also be a sliding scale of prices for radium and X ray treatments according to the financial classification of the patient. When the radium is used in the treatment of private patients, the rental fee is accredited to the income of the cancer clinic. A small fee of 10 to 25 cents may be charged for follow-up visits but this is not stressed too much, otherwise it may discourage these very important visits.

The staff of the tumor clinic should consist of an internist, gynecologist, urologist, dermatologist, rhinolaryngologist, proctologist, pathologist, roentgenologist, general surgeons and consultants, together with specially trained nurses, radium technicians and secretaries.

The director of the tumor clinic should be well qualified by experience and personal interest in the cancer problem and should be preferably on a full time basis. He may be either a pathologist, radiologist, internist, or surgeon, although as the treatment of cancer is largely a surgical problem, the surgeon generally exercises administrative control of the clinic.

The work in a cancer clinic is subdivided and planned so that cancers of the skin are assigned to the dermatologist, cancers of the ovary, uterus, vagina, and vulva to the gynecologist, cancers of the urinary bladder, prostate, testis, kidney, penis, and urethra to the genito-urinary surgeon and cancers of the larynx, pharynx, nose and mouth to the intra-oral surgeon and otolaryngologist. The surgeons in attendance to the clinic may have particular interests in the diagnosis and treatment of cancers of different organs. For example, tumors of the breast may be assigned to one surgeon who by experience or preference justifies this selection. Similar assignments are given for bone tumors, cancers of the esophagus and stomach and for cancers of the colon and rectum.

The efficiency of the clinic improves as these various surgeons acquire particular skill in the surgical and radiological management of tumors in these locations. A consulting dentist is of in-

valuable assistance in the construction of protective dentures for use during the radium treatment of intra-oral cancers and in reconstructive facial surgery.

The internist serves a most important function in the clinic. To him are assigned the diagnosis and treatment of various medical complications that may occur, the various blood diseases such as the leukemias, anemias, polycythemia, also the diagnosis and treatment of the tumors of the lymphoid system such as lymphosarcomata, Hodgkin's disease and others. He may also take special interest in the diagnosis and treatment of mediastinal tumors and of carcinoma of the lung. All the efforts at constitutional therapy of cancer and the dietary management of this disease should be assigned to this department.

The pathologist, who is an integral part of the clinic, should be well trained in the gross and microscopical diagnosis of neoplastic diseases. Another essential in his training and experience is the ability to grade histologically the various carcinomata studied and to judge their radio-sensitivities. He should be adept in frozen section diagnosis and should also be familiar with the rapid preparation of tissues obtained through needle puncture (aspiration) and the various methods of punch biopsy. An attempt should be made to obtain a necropsy on every patient who dies of cancer.

The pathological museum should contain every gross specimen of cancer removed by surgical extirpation and at autopsy. The microscopic slides of every tumor and of every biopsy should also be on file. These should be preserved permanently and catalogued with cross indices so that this material is readily available for study or analysis whenever a special review of this subject is contemplated.

The educational advantages of the clinic are enjoyed by the internes on a rotating service who should be assigned for an aliquot part of their time in the out patient department to the cancer clinic. It is their privilege to examine patients in the clinic and to follow their subsequent management including X-ray, radium, and surgical treatments. The interne is of considerable assistance in the tumor clinic by taking histories, making general physical examinations and by his observations and attendance in the follow up clinics.

The nursing personnel is of great importance. The nurse or nurses assigned to the clinic are considered as permanent members of the organization. With this status they become acquainted with the necessary technical details in the treatment of ambulatory patients by radium and X-

rays, they become familiar with and adept in the preparation of radium applicators, they acquire skill in dressing cancer patients and they are of an especially helpful assistance in certain diagnostic procedures such as esophagoscopy, gastroscopy, bronchoscopy etc. They also learn the modalities for the use of the endotherm knife or surgical diathermy.

The tumor clinic should be provided with a full time competent medical secretary who is thoroughly acquainted with the methods of history taking, recording filing, analyzing end-results, cross indexing and recording doses of radium and X-rays.

The records used in the cancer clinic contain complete data on the history, physical examination, laboratory findings, diagnosis, treatment, and follow up notes of patients with all varieties of cancer. For completeness, uniformity and simplicity it is suggested that these records conform to the system approved by the Committee on the Treatment of Malignant Diseases of the American College of Surgeons. The patients are given a clinic number on application. The case histories are filed and cross-indexed, therefore they may be located in yearly groups, under the patient's name or according to the final diagnosis.

The social importance of the cancer problem must be recognized and the co-operation of the social service department of the hospital obtained. Where this service is lacking, the follow up of cases is performed by other agencies such as the community health center or the personal efforts of the permanent secretary to the tumor clinic. The social service worker is especially fitted to evaluate the social and economic status of the patient. She ascertains if the patient can support his family while under cancer treatment and arranges for the temporary care of minor children. The financing and rehabilitation of the patient after treatment and while convalescing may require community aid which the social service worker provides by mobilizing the resources of the community. The return visits of the patient to the tumor clinic for further treatments and follow up observations are insured by this supervision. Other invaluable services rendered to the patient in his home are proper post-operative and postirradiation management, instruction in the hygienic care of this disease (diet for gastric cancer, hygiene of oral cancer, etc.) and nursing aid to the incurable patient during the terminal period of his disease.

The radiologist or radium technician who assembles the radium in the different applicators or collects and measures radon should be fully

protected against the injurious effect of  $\beta$ - and  $\gamma$  rays. This protection is afforded by several devices kept in the radium assembly room, for example (a) the radium itself is stored in a thick walled lead box within a safe (b) the radium is transported to other parts of the hospital in a heavy metal conveyor or box with a long handle, so that the radium is near the floor and as distant as possible from the body or it is wheeled in a small carriage (c) lead hand shields are built around the handles of the assembly forceps, so that the worker's fingers are not subjected to undue irradiation (d) the radiologist, technician, or nurse stands behind a thick upright lead shield with lead glass top while assembling the various applications.

The radium is kept in a safe, the combination of which is known only to one or two members of the cancer staff preferably the roentgenologist, who is on a full time basis. The safe in this model clinic is built in the same closet with the case records, all of which can be locked again by an outside door. The loan of the radium to the attending staff is done through this caretaker who assumes the sole responsibility for its return. The applications for the use of the radium are filed in chronological order so that no preference is ever shown in its dispensation.

In addition to facilities for X-ray diagnosis, it is essential that the department of radiotherapy be supplied with a high voltage X ray machine of sufficient voltage to insure effective external irradiation. The Committee of the American College of Surgeons on the Treatment of Malignant Diseases states that such an X ray therapeutic unit should have a peak strength of 500,000 volts. This is the standard voltage for most high voltage therapeutic X ray machines in use in the United States today. The machine may be air cooled, or water cooled at 20 to 30 milliamperes the latter set up is more economical and time saving, particularly when there are many patients to be treated.

The working unit in the tumor clinic should be confined as far as possible to one wing of the hospital. In addition to three separate waiting rooms, there should be a general office and a separate record room. A large room containing cubicles with examination tables and dental chairs suitable for ear, nose, and throat examinations and treatments is a necessity. The customary scrubbing sink, small electric sterilizer instrument cabinets, and dressing carriages are also placed in this treatment room especially useful is a light mobile dressing carriage on which may be assembled the instruments necessary for esophagoscopy bron-

choscopy surgical endothermy etc. There is a separate room in this particular clinic for gynecological examinations, an additional room with a cystoscopic table for genito-urinary examinations, two rooms for X ray diagnosis and fluoroscopy the rooms housing the high voltage X ray machine and a separate small waiting room for this unit. A large closet is painted entirely black to serve as a dark room for transilluminations of the breast and oral cavity. This wing of the hospital is situated on the ground floor and has a separate entrance from the street.

There should not be just the one waiting room for all patients coming to the cancer clinic. At least three small waiting or reception rooms are desirable one for new patients, another for patients in the advanced stages of the disease, and a third one for patients who are under treatment and exhibiting the recent effects of radiation therapy or surgery. Some of these effects are quite disturbing to the patient who anticipates such treatment. If the clinic meets officially twice a week, it is well to have women come on one day and men on another in order to avoid possible embarrassment as well as to remove every obstacle in securing ready access to the clinic and its facilities.

There should be on file in the hospital library about fifty of the modern monographs on tumors, radium therapy and X-ray treatment. It should also subscribe to the *American Journal of Cancer Radiology*—the official organ of the North American Radiological Society the *American Journal of Roentgenology and Radium Therapy*—the official organ of the American Roentgen Ray Society and the *American Radium Society SURGERY GYNECOLOGY AND OBSTETRICS (with INTERNATIONAL ABSTRACT OF SURGERY)*—the official journal of the American College of Surgeons and the *Year Book in Radiology*. Practically all worthwhile articles on neoplastic diseases either are published in these journals or are reviewed in their abstract sections.

The personnel of the tumor clinic, the character of the work done the facilities for consultation and diagnosis, the hours for conductance of the clinic, and the equipment and possibilities for proper cancer therapy must be well known to every physician in the immediate vicinity of the hospital. This is important because approximately four fifths (80 per cent) of all patients cared for in the tumor clinic of general hospitals have been referred by doctors and only one-fifth of the total cases have never previously seen a physician. Dentists should be similarly informed the director of the clinic should arrange for appropriate demonstrations and lectures before the local dental

society in the hope of stimulating interest in the early recognition of intra-oral cancer.

The tumor clinic assumes certain educational responsibilities to the physicians of the community as well as to the laity. The centralization or grouping of all the cancer cases in the city enables each physician to see and examine his colleague's cases thereby greatly increasing his experience and familiarity with the various neoplastic diseases. The clinic staff should encourage all physicians to attend the clinics and weekly conferences by a hospitable welcome and a cordial willingness to demonstrate and discuss the cases under observation. A formal educational program consisting of an annual lecture series with out-of-town speakers thoroughly experienced in the diagnosis and treatment of cancer may be arranged with the co-operation of the county medical society or academy of medicine. Information concerning the early signs and symptoms of cancer and the prevention of this disease is dispensed by addresses to women's clubs, luncheon clubs, lodge assemblies, and church societies. Informal afternoon addresses open to the public are given by prominent cancer specialists, who are scheduled on the same date for the evening programs of the medical society. It is well to have the tumor clinic closely allied with the local branch of the American Society for the Control of Cancer. The potential effectiveness of a local branch of this society when properly organized and directed with definite objectives can be illustrated best by the phenomenal success of the Westchester (N. Y.) County Cancer Committee under the able guidance of Dr. H. R. Charlton. This cancer committee a unit of the American Society for the Control of Cancer, is responsible for the best organized and model cancer service in any community in the United States. The experience and support of this national society is an invaluable ally to any new tumor clinic.

A clinicopathological conference every week or two may be arranged for attendance by physicians. It is known as the cancer conference and is conducted by the director of the tumor clinic. The conference is held promptly at a time suitable for the majority of the physicians in the hospital. The program should be prearranged in order to enable physicians who are participating to abstract the case histories and prepare their material for presentation. At such conferences rare and interesting cases are presented as well as tumors presenting difficult problems in clinical or microscopical diagnosis. Other patients are shown and their diagnosis and treatment discussed in order that they may profit by expert group opinion. These opinions are duly recorded

so that when these same patients are presented at some later date the conference may judge for itself the advantages or disadvantages of the method of treatment selected. Stenographic notes of the discussion of all cases are kept and these notes incorporated on the patient's chart together with the tentative diagnoses, names of physicians making the diagnoses, and suggested methods of treatment.

The conference room is well selected and arranged in order that the patient may be easily visible to all the physicians in attendance. The patient is placed on a platform slightly higher than the level of the floor. Illuminated boxes for viewing X-ray films are properly situated. One or two separate dressing booths adjacent to the conference room are helpful in case the consultants find it necessary to make certain examinations (gynecological, rectal, etc.) in private. The conference room is also equipped with a blackboard, a screen and a projectoscope for viewing lantern slides. The case presentations are made by the men most interested; they should be concise and pertinent.

The method of presentation is to give a brief history of the illness and then recite the physical findings and whatever special laboratory tests and diagnostic procedures have been carried out. A few qualified physicians, but not all of the members in attendance are called upon to examine the patient in order that they may discuss the case later. Finally the patient is permitted to leave the conference room before the diagnosis is mentioned and before the discussion concerning the treatment is begun. The diagnosis and the proposals concerning treatment must never be mentioned in the presence of the patient.

Innovations in diagnostic procedures and new departures in treatment are discussed and illustrated by case presentations. The weekly cancer conference also affords opportunities for special or preliminary reports on cancer research in progress or reviews of recent literature concerning certain tumors. At a stated time yearly the conference reviews the 3 and 5 year end results in terms of cures or survivals for this time without evidence of recurrence.

At each conference the pathologist may present interesting surgical or postmortem specimens both in the gross and under the microscope and associate these lesions with a brief review of the case history and clinical findings. A microscope should be so arranged that all members of the clinic may have the opportunity of studying the microscopic structure of those tumors under the tutelage of the pathologist. The members of the cancer conference thus may become acquainted with the nat-



ural history of the disease and are enabled to correlate the clinical appearance, microscopic and gross pathology and the radiosensitivity of the tumor under consideration.

#### SUMMARY

A properly organized tumor clinic in a general hospital with suitable equipment and trained personnel is the most feasible plan for the diagnosis and treatment of cancer in a city of moderate size.

#### REFERENCES

1. CHARLTON, H. R. The Westchester plan. A county method for cancer control. *Surg. Gynec. & Obst.*, 1931, *lii*, 533-536.
2. COCKERILL, E. The rôle of the social worker in the diagnosis and treatment of cancer. *Bull. Am. Coll. Surg.*, 1933, *xvii*, 25-33.
3. Committee on the treatment of malignant diseases, American College of Surgeons. Organization of service for the diagnosis and treatment of cancer—A minimum standard. *Surg. Gynec. & Obst.*, 1930, *li*, 370.
4. CROWELL, B. C. The American College of Surgeons and cancer. *Surg. Gynec. & Obst.*, 1931, *lii*, 625-628.
5. CUTLER, MAX. The organization of a tumor clinic in a general hospital. *Radiology*, 1932, *xix*, 301.
6. DUKES, C. A. Administration of a cancer clinic in a general hospital. *Bull. Am. Coll. Surg.*, 1931, *xv*, No. 4, 5.
7. EWING, J. The cancer research hospital. New York M. J., 1913, Dec. 27. Cancer as a public health problem. *Pub. Health Rep.*, 1930, *xlii*, 3093-3101. Cancer institutes. *Surg., Gynec. & Obst.*, 1932, *lii*, 522.
8. EWING, J., GREENWOOD, R. B. and GERTNER, J. C. A. Medical service available for cancer patients in United States: suggestions for its improvement. *J. Am. M. Ass.*, 1910, *xviii*, 165-169.
9. GREENWOOD, R. B. The tumor clinic of the Massachusetts General Hospital. *Surg. Gynec. & Obst.*, 1931, *lii*, 520-522.
10. KLOFF, E. J. Character of staff conferences of the cancer clinic. *Bull. Am. Coll. Surg.*, 1931, *xv*, 9-10.
11. LEE, B. J. The value of cancer diagnostic clinics. *Bull. Am. Coll. Surg.*, 1931, *xv*, No. 4, 16. The obligation of the general hospital in providing better service for the cancer patient. *Bull. Am. Coll. Surg.*, 1933, *xvii*, 13-16.
12. LOWARD, H. L. State-aided cancer clinics in Massachusetts. *Surg. Gynec. & Obst.*, 1931, *lii*, 336-341.
13. MORTON, J. J. The organization of a tumor clinic in a general hospital. *Surg., Gynec. & Obst.*, 1931, *lii*, 531-535.
14. SODERBERG, CRISTINA C. Reference of hospital cases to the cancer clinic. *Bull. Am. Coll. Surg.*, 1931, *xv*, No. 4, 5.
15. SPENCER, B. T. Description of the cancer hospital of the state institute for the study of malignant disease. *Surg. Gynec. & Obst.*, 1931, *lii*, 515.
16. SMITH, J. W. Cancer organization in France, Belgium, England, Germany and Sweden. *Yale J. Biol. & Med.*, 1931, *lii*, 513.

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVIII

MARCH 1934

NUMBER 3

## ACUTE CIRCULATORY FAILURE AS EXEMPLIFIED BY SHOCK AND HÆMORRHAGE<sup>1</sup>

ALFRED BLALOCK M.D. NASHVILLE, TENNESSEE

From the Department of Surgery of Vanderbilt University

THE title of this lecture is 'Acute Circulatory Failure As Exemplified By Shock and Hæmorrhage'. It seems appropriate that this subject should have been chosen since such noteworthy contributions concerning the etiology of shock have been made by one of Dr. Bevan's former associates, Dr. D. B. Phemister. Various terms have been used to designate the condition which follows severe injury. These include traumatic torpor, stupor, prostration without reaction, syncope, collapse, neuromyopathy, *Wundschreck*, *Erschütterung*, irritation without reaction, exæmia depressant syndrome, traumatic toxæmia, and traumatic hypodromia. The term that has been almost universally adopted is "shock". According to Groenigen, James Latta in 1795 was the first to employ the term 'shock' with the meaning that is now attached to it. Although many objections have been expressed against its use, the clinical picture of shock is clear cut and as long as the term is restricted to this syndrome I can see no objection to its usage. Before proceeding with a consideration of the earlier views on the subject, two excellent descriptions of the clinical picture will be given in detail. The first of these is by John Collins Warren.

A patient is brought into the hospital with a compound comminuted fracture or with a dislocation of the hip joint added to other injuries where the bleeding has been slight. As the litter is gently deposited

on the floor, he makes no effort to move or look about him. He lies staring at the surgeon with an expression of complete indifference as to his condition. There is no movement of the muscles of the face, the eyes which are deep sunken in their sockets have a weird uncanny look. The features are pinched and the face shrunken. A cold clammy sweat exudes from the pores of the skin which has an appearance of profound anæmia. The lips are bloodless and the fingers and nails are blue. The pulse is almost imperceptible; a weak thread-like stream may however be detected in the radial artery. The thermometer placed in the rectum registers 96 or 97 degrees F. The muscles are not paralyzed anywhere, but the patient seems disinclined to make any muscular effort. Even respiratory movements seem for the time to be reduced to a minimum. Occasionally the patient may throw about one of his limbs and give vent to a hoarse weak groan. There is no insensibility but he is strangely apathetic, and seems to realize but imperfectly the full meaning of the questions put to him. It is of no use to attempt an operation until appropriate remedies have brought about a reaction. The pulse however does not respond; it grows feebler and finally disappears and this momentary pause in the act of death is soon followed by the grim reality. A postmortem examination reveals no visible changes in the internal organs.

As another example of a case of shock I will quote the first paragraph from a book entitled *A Bipolar Theory of Living Processes* by Dr. George Crile (25).

When I was a student in medical school I came for the first time in contact with the dramatic picture of failing bodily energies and death. The patient was young and strong; every organ of the body was sound; he had lost but little blood although both legs

<sup>1</sup>The fifth annual Arthur Deas Bressan Lecture in Surgery delivered October 30, 1933, before the Chicago Surgical Society and the Institute of Medicine of Chicago.

had been crushed by a locomotive. As I watched him slowly sink into death the mental and physical prostration, the shrunken, pallid face, the cold sweating skin the fading pulse fixed the picture in my mind. Autopsy revealed no lesion in any vital organ. Immediately I planned a research for the purpose of attempting to find what essential mechanism had failed. As I watched the pulse fading so inevitably I thought that death was due to the want of circulation as the result of heart failure but what had caused the heart to fail? It was not hemorrhage, but it appeared to me that failure of the circulation to whatever it was due, must have been the primary cause of death and this belief directed the course of my initial studies.

No doubt many others who have studied shock have been prompted to do so because of similar experiences, and this same feeling of a lack of the knowledge requisite for rendering helpful service.

#### HISTORICAL RESUME

Since man has always been subject to fatal accidents which are usually associated with hemorrhage it is probable that blood has been regarded as the vital fluid essential to active existence since early times. This belief (2) explains why red objects as substitutes for blood were used so frequently in the rites of primitive peoples. The dead were buried in red ochre probably with the object of supplying vitality and of restoring activity to the corpse. Crimson pebbles and other red objects were buried with the dead. In historic times, the Egyptians placed upon mummies a red amulet of carnelian or jasper which typified the blood of the goddess Isis. This was done either to stimulate the functions of the blood or to act as a substitute for the blood that was lacking. The ancient myths that ascribed the origin of trees and plants to blood have their modern counterpart in the custom of the Central Australian natives who swallow blood during severe illness in order to gain renewed vitality (76).

The earliest known pictures of surgical operations are to be found on the door posts of a tomb near Memphis, Egypt (38). These engravings which were made approximately twenty-five centuries before Christ, portray operations on the extremities and circumcision. With the exception of these procedures and other simple operations the treatment of

wounds constituted the major portion of surgery. It continued to be wound surgery in the main until late in the nineteenth century. Modern surgery began only after knowledge of the nature of infections and methods of preventing pain were added to what was known concerning the structure of the human body and methods of controlling loss of blood.

Every branch of surgery is heavily indebted to the information that has been gained in the past and is being gained at present from a study of wounds of various parts of the body. Hippocrates, who said that war is the only proper school for the surgeon, did not describe shock, but he recognized important principles concerning the prognosis in the wounded. He stated (44) "Wounds are very dangerous when there is some large nerve, vein, or artery injured, for the convulsion and the flow of escaping venal or arterial blood prostrates the wounded one and exhausts his strength. Although wounds have occupied the attention of the medical profession for centuries and the study of them has contributed so much to the development of surgery, the cause of death following injury to large masses of tissue has never been explained to the satisfaction of the majority of surgeons and physiologists. This problem has intrigued the imagination of many of the greatest physicians.

Shock was described by Ambroise Paré (45) under the title of "Syncope and Heart Failure." His description corresponds with what is today known as primary shock or collapse. Some of his ideas on the subject are contained in the following quotation:

Syncope is a sudden and strong failure of the faculties and senses, and principally of the vitality and the sick one remains without any movement. The signs of syncope are when the ill one pales, and when there comes to him a slight sweat cessation of the movement of the arteries, whereupon soon afterwards he falls to the ground, without any feeling and movement, and becomes seemingly cold throughout, in such fashion that he resembles more a dead man than a live one. Many who fall in syncope, if they are not succored, die.

According to Seabrook William Clowes in 1568 Wiseman in 1719 and Garengnot in 1723 recognized shock and attributed it to the presence of some foreign matter in the wound or in the blood.

Shock was usually discussed by the earlier writers under the title of inflammation or irritation. The ideas of John Hunter on the subject are expressed in his work dealing with suppurative inflammation and with gunshot wounds. He stated

Nature requires to feel the injury for where after a considerable operation there is rather a weak, quiet pulse often with a nervous oppression, with a seeming difficulty of breathing and a loathing of food, the patient is in a dangerous way. Fever shows powers of resistance the other symptoms show weakness and sinking under the injury

Hunter considered the amputation of extremities of soldiers injured at war inadvisable since the operation was a violence added to the injury. He stated

In the first case it is only inflammation in the second it is inflammation loss of substance and most probably loss of more blood, as it is to be supposed that a great deal has been lost from the accident not to mention the awkward manner in which it must have been done

It is rather difficult to reconcile this view with his further ideas concerning the treatment of injuries. He stated

The bark and gentle bleedings, when the pulse begins to rise are the best treatment that I know of in inflammations that arise either from accidents or operations. One lessens the volume of the blood and the increased animal powers at the time, which makes the circulation more free so that the heart labours less and simple circulation goes on more freely the other gives the blood that which makes it less irritating makes the blood vessels do their proper offices, and gives to the nerves their proper sensations which take off the fever

These views should not seem crude when it is remembered that they were expressed approximately 150 years ago

It is interesting to note the influence exerted by the prevailing practices of the time on the ideas of a man who thought as clearly as did John Hunter. In spite of the statements indicating a remarkably clear perception of the dangers of a diminished blood volume he yielded to the prevailing opinion and recommended bleeding. One of the most ardent advocates of blood letting during Hunter's time was Broussais. It is stated (39) that the yearly importation of leeches into France increased from two million to forty million as a

result of his influence. Blood letting was almost abandoned in the middle of the nineteenth century. Doctor Tully said, "The lancet is a weapon which annually slays more than the sword."

Bichat the creator of descriptive anatomy and a successful French surgeon did not accept Hunter's theory of inflammation as the essential cause of shock, but entertained ideas which were more in keeping with Paré's conception of circulatory failure. Concerning the causes of death, he stated

Here then is the great difference which distinguishes death by old age from that which is the effect of a sudden blow in the former life begins to be extinguished first in all the parts and ceases at last in the heart death extends its empire from the circumference to the center. In the latter life is extinguished first in the heart and then in all the parts in this case it is from the center towards the circumference that death displays its phenomena.

Sir Astley Cooper (81) a pupil of Hunter's discussed the manner in which injuries produce death in a lecture on "Irritation." He stated

Injuries producing fatal consequences destroy life in three different modes. Firstly, when slight, by keeping up a continued constitutional irritation, they gradually wear out the system. Secondly when more severe, they destroy by occasioning excess of action. Thirdly the most severe, by shock to the nervous system, causes death without reaction. Thus, I have seen a person admitted into Guy's Hospital, who had a laden wagon pass over his knee the bones were crushed but there was no wound or hemorrhage, yet the person died a few hours after his admission. I have seen also a man who fell into a vat of hot beer by which both his lower extremities were scalded, but the body escaped any direct injury. This man's pulse was very small and feeble his skin was cold his teeth chattered reaction took place and he died in eight hours not withstanding stimulants were freely given. I have known a limb amputated for compound fracture above knee, and the patient die in four hours after without any reaction the body was covered with a cold perspiration and the pulse was scarcely perceptible.

Benjamin Travers a pupil of Sir Astley Cooper's and senior surgeon to St. Thomas Hospital expressed opinions concerning shock that were quite different from those held by his predecessors. These are contained in a book published in 1820 entitled, *An Inquiry Concerning That Disturbed State of the Vital*

had been crushed by a locomotive. As I watched him slowly sink into death the mental and physical prostration the shrunken pallid face the cold sweating skin the fading pulse, fixed the picture in my mind. Autopsy revealed no lesion in any vital organ. Immediately I planned a research for the purpose of attempting to find what essential mechanism had failed. As I watched the pulse fading so inevitably I thought that death was due to the want of circulation as the result of heart failure but what had caused the heart to fail? It was not hemorrhage, but it appeared to me that failure of the circulation to whatever it was due, must have been the primary cause of death and this belief directed the course of my initial studies.

No doubt many others who have studied shock have been prompted to do so because of similar experiences, and this same feeling of a lack of the knowledge requisite for rendering helpful service.

### HISTORICAL RESUME

Since man has always been subject to fatal accidents which are usually associated with hemorrhage it is probable that blood has been regarded as the vital fluid essential to active existence since early times. This belief (37) explains why red objects as substitutes for blood were used so frequently in the rites of primitive peoples. The dead were buried in red ochre probably with the object of supplying vitality and of restoring activity to the corpse. Crimson pebbles and other red objects were buried with the dead. In historic times the Egyptians placed upon mummies a red amulet of carnelian or jasper which typified the blood of the goddess Isis. This was done either to stimulate the functions of the blood or to act as a substitute for the blood that was lacking. The ancient myths that ascribed the origin of trees and plants to blood have their modern counterpart in the custom of the Central Australian natives who swallow blood during severe illness in order to gain renewed vitality (76).

The earliest known pictures of surgical operations are to be found on the door posts of a tomb near Memphis Egypt (38). These engravings which were made approximately twenty five centuries before Christ, portray operations on the extremities and circumcision. With the exception of these procedures and other simple operations, the treatment of

wounds constituted the major portion of surgery. It continued to be wound surgery in the main until late in the nineteenth century. Modern surgery began only after knowledge of the nature of infections and methods of preventing pain were added to what was known concerning the structure of the human body and methods of controlling loss of blood.

Every branch of surgery is heavily indebted to the information that has been gained in the past and is being gained at present from a study of wounds of various parts of the body. Hippocrates, who said that war is the only proper school for the surgeon, did not describe shock but he recognized important principles concerning the prognosis in the wounded. He stated (44) "Wounds are very dangerous when there is some large nerve vein or artery injured for the convulsion and the flow of escaping venal or arterial blood prostrates the wounded one and exhausts his strength." Although wounds have occupied the attention of the medical profession for centuries and the study of them has contributed so much to the development of surgery the cause of death following injury to large masses of tissue has never been explained to the satisfaction of the majority of surgeons and physiologists. This problem has intrigued the imagination of many of the greatest physicians.

Shock was described by Ambroise Paré (45) under the title of Syncope and Heart Failure. His description corresponds with what is today known as primary shock or collapse. Some of his ideas on the subject are contained in the following quotation:

Syncope is a sudden and strong failure of the faculties and senses, and principally of the vitality and the sick one remains without any movement. The signs of syncope are when the ill one pales, and when there comes to him a slight sweat cessation of the movement of the arteries, whereupon soon afterwards he falls to the ground without any feeling and movement, and becomes seemingly cold throughout in such fashion that he resembles more a dead man than a live one. Many who fall in syncope, if they are not succored, die.

According to Seabrook William Clowes in 1568 Wiseman in 1719 and Garengnot in 1723 recognized shock and attributed it to the presence of some foreign matter in the wound or in the blood.

Shock was usually discussed by the earlier writers under the title of inflammation or irritation. The ideas of John Hunter on the subject are expressed in his work dealing with suppurative inflammation and with gunshot wounds. He stated

Nature requires to feel the injury for where after a considerable operation there is rather a weak, quiet pulse often with a nervous oppression, with a seeming difficulty of breathing and a loathing of food, the patient is in a dangerous way. Fever shows powers of resistance the other symptoms show weakness and sinking under the injury.

Hunter considered the amputation of extremities of soldiers injured at war inadvisable since the operation was a violence added to the injury. He stated

In the first case it is only inflammation in the second it is inflammation, loss of substance and most probably loss of more blood, as it is to be supposed that a great deal has been lost from the accident, not to mention the awkward manner in which it must have been done.

It is rather difficult to reconcile this view with his further ideas concerning the treatment of injuries. He stated

The bark and gentle bleedings when the pulse begins to rise, are the best treatment that I know of in inflammations that arise either from accidents or operations. One lessens the volume of the blood and the increased animal powers at the time, which makes the circulation more free so that the heart labours less and simple circulation goes on more freely the other gives the blood that which makes it less irritating makes the blood vessels do their proper offices and gives to the nerves their proper sensations which take off the fever.

These views should not seem crude when it is remembered that they were expressed approximately 150 years ago.

It is interesting to note the influence exerted by the prevailing practices of the time on the ideas of a man who thought as clearly as did John Hunter. In spite of the statements indicating a remarkably clear perception of the dangers of a diminished blood volume he yielded to the prevailing opinion and recommended bleeding. One of the most ardent advocates of blood letting during Hunter's time was Broussais. It is stated (39) that the yearly importation of leeches into France increased from two million to forty million as a

result of his influence. Blood letting was almost abandoned in the middle of the nineteenth century. Doctor Tully said "The lancet is a weapon which annually slays more than the sword."

Bichat, the creator of descriptive anatomy and a successful French surgeon, did not accept Hunter's theory of inflammation as the essential cause of shock, but entertained ideas which were more in keeping with Paré's conception of circulatory failure. Concerning the causes of death, he stated

Here then is the great difference which distinguishes death by old age from that which is the effect of a sudden blow in the former life begins to be extinguished first in all the parts and ceases at last in the heart death extends its empire from the circumference to the center. In the latter life is extinguished first in the heart, and then in all the parts in this case it is from the center towards the circumference that death displays its phenomena.

Sir Astley Cooper (81) a pupil of Hunter's discussed the manner in which injuries produce death in a lecture on "Irritation." He stated

Injuries producing fatal consequences destroy life in three different modes. Firstly, when slight, by keeping up a continued constitutional irritation, they gradually wear out the system. Secondly, when more severe, they destroy by occasioning excess of action. Thirdly, the most severe, by shock to the nervous system, causes death without reaction. Thus, I have seen a person admitted into Guy's Hospital, who had a laden wagon pass over his knee, the bones were crushed but there was no wound or hemorrhage, yet the person died a few hours after his admission. I have seen also a man who fell into a vat of hot beer by which both his lower extremities were scalded but the body escaped any direct injury. This man's pulse was very small and feeble his skin was cold his teeth chattered reaction took place and he died in eight hours notwithstanding stimulants were freely given. I have known a limb amputated for compound fracture above knee and the patient die in four hours after without any reaction the body was covered with a cold perspiration, and the pulse was scarcely perceptible.

Benjamin Travers, a pupil of Sir Astley Cooper's and senior surgeon to St Thomas Hospital expressed opinions concerning shock that were quite different from those held by his predecessors. These are contained in a book published in 1820 entitled *An Inquiry Concerning That Disturbed State of the Vital*

*Functions Usually Denominated Constitutional Irritation* That his ideas differed considerably from those of Hunter Cooper and others is shown by the following quotation

I am far from presuming to gainsay these authorities, but I am disposed to consider apart from fever or constitutional inflammation the nervous affections, to regard them as a distinct order of morbid actions occasionally ensuing upon injuries, upon inflammation upon the exhaustion attending loss of blood, and upon the admission of noxious matters into the circulation

Although the fact of death ensuing upon injuries of parts not essential to life even when unattended by hæmorrhages, and upon operations not usually esteemed hazardous, has not escaped observation writers and teachers seem to have contented themselves with the bare statement of it, either from an impression that being an equivalent in effect to death on the spot or being due to an idiosyncrasy, moral or physical the further consideration of the subject in a practical view was unavailing

It is further stated by Travers

There is reason to believe that a regular series of impressions and actions maintained between the nervous and muscular systems is indispensable to animal existence and that an interruption, derangement, or suspension of these is occasionally the result of a sudden and violent shock, mental or corporeal, or of the two combined which is fatal or recoverable according to the greater or less intensity of the shock and the permanency of the condition from which it originated

I have called this state prostration because the term is descriptive without involving an hypothesis to explain it. It is a state not actually amounting to but threatening or nearly approaching a cessation of vital action. Whether it be the direct result of the shock or of an exhaustive effort of nature to meet the emergency—as those persons may suppose who look instinctively for final cause and resolve every action into a salutiferous or restorative operation—I will not presume to decide but it would be utterly subversive of my notion of the case to suppose that nature is in a condition to make any arrangement for her "own relief"

Travers did not agree with Hunter Cooper Broussais, and others concerning the value of blood-letting. He said

The custom of letting blood indiscriminately after injuries is so irrational, that the authority of long established customs forms no excuse for it. Prophylactic blood-lettings may be proper in certain cases, as in threatened apoplexy or where hæmorrhagic conditions prevail in perturbed women etc. but they are seldom admissible where injuries have been inflicted. I have seen a practitioner tie up the arm of a person to bleed him after a fall, in a pale cold

stun in which the pulse could scarcely be felt at the wrist. I have known operators permit a large artery to bleed before tying it, in amputations unexpectedly performed on very robust subjects. It is easy to see the motive of such operators, but it is an erroneous pathology and a dangerous practice the effects attending upon loss of blood are peculiar and the reduction of strength by these means has no analogy whatever to that which is brought about by chronic disease, and renders the effects of operations less formidable.

I have quoted from the writings of Benjamin Travers at length because his ideas concerning shock particularly as regards the treatment were far in advance of his time, and in fact, they are more sound than many opinions that have been expressed subsequently

An interest in the prevention of shock was expressed by Larrey the distinguished military surgeon who was characterized by Napoleon as the most virtuous man he had ever known (17). He emphasized the need for the evacuation of the wounded from the field of battle and he effected a marked improvement in the ambulances which were in use at that time (54)

During the last third of the past century there appeared numerous publications on the subject of shock. The important experimental work of Goltz will be referred to later. Weir Mitchell who together with Morehouse and Keen observed many nerve lesions during the Civil War attributed shock to a reflex disturbance, or in some cases paralysis of the centers. Le Gros Clark defined shock as follows

The peculiarity of shock, then, is this vital depression generally sudden which follows the exciting cause, whatever that may be, and which is marked by the influence thus exercised primarily on the nerve centers and heart and secondarily by implication or sympathy and necessarily through the intervention of nerves, on the organs of respiration, of assimilation and secretion, and on the senses.

Samuel D. Gross defined shock as a rude unhinging of the machinery of life. He believed it to be a depression of the vital powers due in the main to a loss of innervation. Shock and hæmorrhage were contrasted by him as follows

Shock bears in effect, the same relation to the nervous system as syncope to the vascular. In the one case the result is caused by a diminution of

nervous fluid in the other by a diminution of blood in both, the consequence is more or less prostration with perturbation of mind and body, extremely variable as to intensity and duration. When blood flows away in a mighty and overwhelming torrent the person dies and life is then said to be destroyed as it certainly is by the excessive sanguineous drain age. But in shock the same effect may happen and yet the body be literally surcharged with blood not a single drop, perhaps, having been spilled in the accident causing the fatal result. Thus, of the two fluids the nervous is in every respect the more important because the more essential to life and its disturbance is therefore a more frequent cause of death.

Billroth who was among the first in Germany to devote particular attention to shock ascribed it to a molecular disturbance of the brain. Blum attributed it to an arrest of the heart's action due to reflex irritation of the vagus nerve. Savory described shock as follows: "Death from shock then is the result of a sudden and violent impression on some portion of the nervous system acting at once through a nerve center upon the heart and destroying its action. It was Savory who made the often quoted remark that 'Action involves exhaustion and repose is needed for repair. The greater the effort therefore the greater the exhaustion.' Jordan in The Hastings Lecture on Shock defined it as a peculiar condition of the animal system characterized by depression of all its functions the result of a powerful impression applied to the nervous centers or to a portion of the peripheral nervous system. Concerning the prevention of shock he stated:

If I were going to have my thigh amputated without the protection of long disease I would ask that ether should be given to me many hours before the operation that I might approximate as nearly as possible to early infancy the stupidity of prolonged disease or the hibernation of animals. The best protection against shock is a state similar to shock, namely anaesthesia to the extent of sleep for many hours.

The most significant of the early experimental work on shock was that of Goltz (39, 40). He found that repeated blows on the viscera of the suspended frog caused reflex inhibition of the heart through the vagus and a lessening of vascular tone generally throughout the body and especially in the

abdominal cavity. Goltz produced by this method what is known as "primary shock" or "collapse" and little has been added to our information concerning the condition since his results were reported. The explanation which he gave seems to be entirely satisfactory. Fischer reasoning from the experiments of Goltz assumed that traumatic or secondary shock is due to vasomotor paralysis resulting in the accumulation of the greater part of the blood in the splanchnic area and an anemia of other parts of the body. The vascular disturbance was considered the primary cause and all other symptoms were secondary phenomena. It might be well at this point to define the present usage of the terms 'primary shock' and 'secondary shock'. Primary shock or collapse refers to the condition in which a decline in the blood pressure and the appearance of the symptoms of shock are noted immediately following the injury. In secondary shock the time interval separating the injury and the appearance of symptoms is usually an hour or more. In some instances primary shock may progress into the secondary type.

Groeninger believed that severe injury resulted in shock because of damage to the medulla and spinal cord. He took exception to the theory of vasomotor paralysis as enunciated by Fischer and showed that Goltz himself did not regard the condition he studied as shock but rather as syncope or fainting. In rabbits subjected to the experimental procedure used by Goltz, Groeninger was unable to demonstrate anemia in the peripheral vessels. In rabbits dying as a result of trauma he found that the abdominal arteries and veins were empty. In discussing the theory of vasomotor paralysis John Collins Warren stated: "It has certainly been the writer's experience that the symptoms of shock are not accompanied by any marked change in the blood supply to the abdominal vessels."

#### REVIEW OF MORE RECENT LITERATURE

The views of Crile (24) on the subject of shock have been extensively quoted throughout the world. As a result of many experiments he came to the conclusion that shock is due to exhaustion of the vasomotor center



consequent to overstimulation. According to Crile shock may be produced by varied causes such as fear worry physical injury infection etc. This is the kinetic view of shock, that is, that exhaustion is the natural result of over action. The so called shockless operation where worry fear and rough manipulation are reduced to a minimum has been advocated by Crile. As a result of his teachings, the incidence of shock following operations has been greatly reduced and the treatment of shock has been improved. Halsted Carrel and others have made noteworthy advances in this respect. On the other hand many of the experimental findings and theories of Crile have not been supported by the work of Seelig and Lyon (74) Forbes and Miller (33, 34) Dolley (28) Erlanger Gesell and Gasser (29) Burch and Harrison (19) and Kocher (53). Porter (65, 67, 68) stated that shock is not due to an exhaustion or depression or inhibition of the vasomotor cells. In an excellent paper entitled "The Peripheral Origin of Surgical Shock," Mann (57) stated:

It is impossible to reduce the anesthetized animal to a state of shock by any degree of sensory stimulation provided all hemorrhage is prevented and its abdomen is not opened.

Mansell Moullan assumed that the vasomotor changes in shock were produced by inhibition rather than by simple reflex paralysis. Howell divided shock into the cardiac and vascular types. He assumed that both types were due to an inhibition of the centers in the medulla, that is, an inhibition of the tone of the vagus center caused the rapid heart rate and inhibition of the vasomotor center lead to vascular shock. Meltzer subscribed to the inhibition theory. He stated: "On the basis of these considerations I venture the assumption which is not new that the various injuries which are capable of bringing on shock do so by favoring the development of the inhibitory side of all the functions of the body."

The possible relationship of fat embolism to shock has been suggested by many writers. The literature on the subject was thoroughly reviewed by Warthin in 1913. Groenigen popularized this view by calling attention to the reported cases in which fat embolism following injuries had supposedly resulted in

death. He stated however that the symptoms following fat embolism must not be confused with those of shock. Porter (66) in 1919 stated that shock resulting from emboli of fat is not due to embolism of the lungs but rather of the vasomotor region.

Two theories have been offered as to the relationship of the adrenal glands to the state of shock. One maintains that it is due to over activity of the adrenal glands and the other states that it is due to exhaustion. Bainbridge and Trevan (60) and Erlanger and Gasser (31) produced shock by the injection of large amounts of adrenalin. Freeman (37) has recently caused a diminution in the blood volume by the injection of smaller amounts. Some observers have found that the adrenin content of blood is increased while others have noted no alteration. Mann (56) found that total excision of the adrenals does not reproduce the phenomena of shock. The evidence was summarized by Cannon (20) as follows:

Neither the suggestion of overactivity nor the suggestion of underactivity of the adrenals has sufficient evidence in its favor to warrant attributing shock to the adrenal glands."

The suggestion was made recently by Swingle Pfaffner Vars Bott, and Parkins (78) that the signs and symptoms of adrenal insufficiency and of traumatic or secondary shock are possibly due to one and the same thing namely failure of the blood volume and blood diluting regulating mechanism, the adrenal cortex. As has been pointed out by Freeman (36) convincing evidence that the two conditions have a common etiology has not been presented.

It has been suggested that shock is due to acidosis or decrease in the alkaline reserve. Dale and Richards (70) found that the carbon dioxide capacity of the blood can be reduced to a low level without causing permanent changes in the blood pressure. A prolonged low blood pressure from any cause is associated with a reduction in the alkali reserve, but it is a result rather than the cause of the decline in blood pressure.

Yandell Henderson in 1908 suggested that shock is due to acapnia or excessive respiration and this theory has been elaborated by

him in an extensive series of papers since that time. He stated that pain, sorrow, fear and operation cause excessive respiration; this reduces the carbon dioxide content of the blood and other changes ensue. Many writers including Groenningen, Clark, Mitchell and Cannon have noted that the severely wounded do not immediately experience severe pain. The respiratory rate in the wounded is usually increased but the respirations are shallow. Vigorous hyperpnea is rarely observed. Cannon (21) summarizes the evidence in regard to the acapnia theory as follows:

As the foregoing discussion has revealed, none of the relations between acapnia and shock, which are postulated by the theory are fixed—pain and the excessive breathing required for acapnia are commonly absent, shock may exist without acapnia and acapnia may exist without shock, and the low carbon dioxide content of the blood in shock can be accounted for as the result of the low blood pressure, not as its cause.

An important advance in the development of the present conception was made in 1879 when Mapother in an address before the Surgical Society of Ireland stated that the most marked physical change caused by shock was a contraction of the arterioles. He assumed that the dilator nerves were paralyzed. In regard to the theory of vasoconstriction, Malcolm stated: "To sum up: The theory that the vessels are intensely contracted during shock offers a full solution of all the difficulties that I have pointed out as arising when the vessels are assumed to be paralyzed." Boiss maintained that the essential cause was sympathetic irritation manifested mainly by tonic contraction of the heart and arteries. According to Starling, the hypertonicity of the arteries and the hypotonicity of the muscles in shock result in a slow flow of blood through the muscles and in an accumulation of blood there with a decrease in the circulatory blood volume. Erlanger and his associates (30) produced vasoconstriction and a decrease in the blood volume by several different methods and noted that the capillaries and venules of the intestinal villi were distended with red blood corpuscles. As a result of these and other investigations it is almost universally believed at present that secondary shock is

associated with vasoconstriction and with a decrease in the blood volume. It is only in the terminal stages that the constriction is replaced by dilatation. Convincing evidence that the blood volume is diminished was furnished by Keith in 1919. As a result of these findings, most of the theories that have been discussed became untenable.

During the World War, committees were appointed in various countries for the purpose of studying shock and many important findings resulted from their work. They are summarized in Cannon's excellent monograph (20) entitled *Traumatic Shock*. As a result of many experiments by various workers and of clinical observations notably by Quénu, the toxæmia theory was formulated. The most often quoted experiments are those that were performed by Cannon and Bayliss (22) in which shock was produced by traumatizing one of the posterior extremities of anesthetized cats. They found that there was not a sufficient loss of blood into the injured area to account by itself for the decline in blood pressure. Section of the spinal cord in the upper lumbar region in some experiments showed that the fall in blood pressure was not due to any general effect of the trauma on the circulation brought about by nervous agencies. The decline in blood pressure could not be explained on the basis of fat embolism or acapnia or acidosis. It was assumed that the continued fall in blood pressure was due to the absorption of some depressant substance from the injured area into the general circulation. The effects of injecting histamine and of traumatizing muscles were compared in various manners and it was believed that the hypothetical depressant produced by injuring muscles was either histamine or some closely related substance.

Before proceeding with a consideration of recent studies, I will attempt to summarize briefly the more important points that have been brought out thus far. Primary shock refers to the state of collapse that follows immediately the receipt of an injury. A satisfactory explanation for this condition seems to have been obtained by Goltz (39, 40) in experiments in which it was found that the initial alteration in the circulatory system was

vasodilatation. Secondary shock refers to the type in which the interval separating the injury and the development of unfavorable symptoms is usually an hour or longer. It has been in an effort to explain this condition that most of the theories have been advanced. Perhaps the most divergent views have been expressed by those who maintain that shock is associated with a general relaxation of the vessels and those who state that it is accompanied by vasoconstriction. Evidence of a convincing nature has been offered to show that secondary shock except in the terminal stage is associated with vasoconstriction. The proven facts in the case are that it is accompanied by a diminution in the blood volume and a decrease in the blood pressure. As a result of these findings, most of the theories have become untenable. During the past 15 years the toxæmia theory has been rather generally accepted. This theory differs from the others which consider a diminution in blood volume vasoconstriction and capillary congestion as the essential disturbances in secondary shock in that evidence as to the initiating agent is suggested. It has in common with the other theories the fact that no initiating agent has actually been demonstrated.

#### A CONSIDERATION OF SHOCK DUE TO (1) UNCOMPLICATED HÆMORRHAGE AND (2) TRAUMA TO MUSCLES

For a detailed discussion of recent contributions to our information concerning shock, I have chosen to consider in the main the results of experiments in which shock was produced in some instances by the removal of blood and in others by injuring muscles. If the results of experiments are to have a clinical application it is necessary that the general phenomena that are produced should be closely similar to those that are observed in patients. I think that the studies which are to be reported meet this requirement.

The results of the earlier experiments of Smith, of Phemister and Handy and of Blalock and Bradburn (13) which will not be described in detail here, did not lend support to the hypothesis that traumatic shock is caused by a toxin. These results prompted Par-

sons and Phemister and myself (6) to repeat the experiments of Cannon and Bayliss (12) which contributed the main evidence for the toxæmia theory. Injury was produced by striking one of the posterior extremities of deeply anesthetized dogs many blows with a hammer. It was observed that the swelling which followed the injury was not limited to the area directly traumatized but extended to the groin and flank. Cannon and Bayliss performed the amputations by symmetrical incisions across the upper thighs in their experiments in which they determined the local loss of blood into the injured area. Hence, it seemed that their amputations had not been performed at sufficiently high levels if the entire loss of fluid into the injured tissues was to be determined. In both my experiments and those of Phemister and Parsons, the amputations were performed above the site to which the swelling extended and the difference in the weights of the injured and non injured extremities was determined. This difference indicated the loss of approximately one-half of the total blood volume into the injured extremity and it was sufficiently great to account by itself for the decline in blood pressure. These experiments were of approximately the same duration as those of Cannon and Bayliss and similar anesthetics were used. Parsons and Phemister found that a dilution of the blood remaining in the vessels followed trauma to an extremity while an increase in the concentration of the red blood cells was usually noted in my experiments (6). This variation in the results was probably due to differences in the severity of the trauma. Very severe trauma with the associated rupture of large vessels results in the loss of blood of approximately the same composition as it exists in the blood stream and a dilution of the remaining blood occurs. Milder trauma causes the loss of a greater proportion of plasma than of red cells and a concentration of the blood occurs.

Many other experiments (6) of a different nature have been performed. If the femoral artery was isolated in the groin and a tourniquet was placed tightly around the upper thigh compressing all structures except the artery it was found that severe trauma distal

to the tourniquet caused the death of the animal. Here also the difference in the weights of the two extremities indicated that the decline in pressure was due to the local loss of fluid. Parsons and Phemister found that in injury to an extremity, the femoral vein of which had been ligated, resulted in more rapid swelling and fall in pressure than was the case when the vein was not ligated. In other experiments (6) which I performed, the femoral artery and vein were exposed in the groin, the vein was occluded by a bulldog clip and a tourniquet which constricted all of the structures of the thigh except the artery and vein was placed beneath the vessels. Removal of the clip from the vein did not cause a decline in blood pressure in experiments in which gross injury was or was not produced. When the arterial inflow and the venous outflow of an extremity were entirely occluded, gross trauma to the extremity did not produce a decline in the blood pressure. The transfusion of blood from one dog in which a low blood pressure had been caused by trauma to an extremity to another dog in which a low blood pressure had been produced by a loss of blood either outside the body or into the tissues resulted in an elevation of the blood pressure of the recipient. No evidence was obtained in these experiments that a histamine like substance was responsible for the decline in blood pressure following severe injury to an extremity. Parsons and Phemister concluded that reflex vasomotor paralysis or exhaustion did not account for the circulatory failure since intensive stimulation of somatic nerves produced elevation instead of fall in blood pressure and equal amounts of traumatism to denervated and innervated extremities produced the same amount of fall in pressure in each. Freeland and Lenhardt have confirmed these results. I have recently performed experiments (10) similar to those that have been described, using spinal anesthesia instead of ether or barbital. The results were almost identical with those that were obtained when ether or barbital was used.

In the experiments referred to thus far, the average time between the production of trauma and the advent of death was approximately 3 hours. Although these experiments

were of the same duration as those of Cannon and Bayliss, it is believed that they were not sufficiently long to rule out the possible action of all protein decomposition products. Other experiments (8) were therefore performed in which this objection was partially overcome by decreasing the severity of the trauma and hence increasing the survival period of the animals. The length of these experiments was limited because the anesthesia was necessarily profound. The average duration was 32 hours. The fluid that escaped into the tissue spaces at the site of injury was found by Beard and Blalock (1) to have almost exactly the same composition as the plasma in the blood vessels. It might be remarked here that the fluid lost locally as a result of intestinal trauma or burns is also blood plasma. It is important that the protein content of the blood plasma and of the lost fluid are approximately the same because protein is the constituent that maintains to a large degree the osmotic pressure in the blood vessels. The quantity of fluid that had escaped into the injured extremity was determined following death. The results of these experiments were compared with those obtained in other studies (48) in which death was produced by the removal of plasma from the blood stream. This comparison showed that the decrease in blood volume as a result of the loss of plasma into the injured tissue spaces was sufficient to account for the decline in blood pressure. Similar results have been obtained in other experiments of rather short duration performed under profound anesthesia. In some of these (7) the intestines were traumatized and in others (9) large areas of skin were burned. In all of these studies there was a marked increase in the concentration of the red blood cells.

The relative absorptive powers of traumatized and normal tissues were determined in experiments (26) in which phenolsulphone phthalein or strychnine were injected into anesthetized dogs. It was found that the substances were absorbed very slowly from the tissues of an injured extremity. The rate was more rapid when the injections were made into the uninjured tissues of either normal dogs or dogs which had had an extremity

traumatized Underhill, Kapelow and Fisk found that absorption from a burned area is much slower than it is under normal conditions.

Further evidence as to the mechanism of the production of shock was obtained in experiments in which the output of the heart and the blood pressure were determined frequently during its development. When hemorrhage was produced by the slow removal of blood from a large vessel it was found (5) that the output of the heart diminished considerably before a definite alteration in the blood pressure took place. Trauma to an extremity (49) was followed by alterations similar to those produced by hemorrhage. On the other hand, following the injection of histamine the blood pressure declined first and the cardiac output subsequently. Primary shock (10) the introduction of large amounts of novocain into the spinal canal (18) and bilateral adrenalectomy (11) are associated with alterations in the cardiac output and blood pressure similar to those that are produced by the injection of histamine. Trauma to the central nervous system (12) is usually accompanied by a simultaneous decline in the cardiac output and blood pressure. The only point which I wish to emphasize here is that uncomplicated hemorrhage and trauma to an extremity are both associated with first a decrease in the output of the heart followed by a decline in the blood pressure while the alterations appear in the reverse order as a result of the injection of histamine.

Roome Keith and Phemister performed experiments in which the blood pressure was reduced to a shock level by various procedures such as the removal of blood, trauma to an extremity, the injection of histamine, hyper-ventilation, the introduction of novocain into the spinal canal and the production of anaphylactic shock. The quantity of blood that it was necessary to remove in order to cause death was then determined. It was found that the removal of a very small amount of blood resulted in death in the experiments in which a low blood pressure had been produced by hemorrhage and in those in which an extremity had been traumatized. It was necessary to remove much larger quantities in the

experiments in which a decline in pressure had been produced by other means.

Observations (10) of a somewhat similar nature were made recently in the course of some of my experiments. The painless death of a large number of dogs was produced by methods which included the removal of blood, trauma to an extremity, the injection of histamine, the injection of acetyl-choline, and the introduction of fluid under pressure into the pericardial cavity. Immediately following death the pleural and peritoneal cavities were opened widely. After the attachment including the blood supply of the various organs was cut across, the blood which drained freely from them without pressure being exerted was allowed to flow into the cavities. The organs were then removed. The amount of free blood remaining in the pleural and peritoneal cavities was determined. Approximately the same quantities of blood were recovered in the experiments in which death was produced by hemorrhage and by trauma to an extremity. More than twice as much blood was present in the cavities in the experiments in which death was caused by other means.

The general belief is current that shock and hemorrhage are very different phenomena. It is quite true that they may be in certain instances. As an example of this belief the following paragraph from a recent editorial in the *Journal of the American Medical Association* (51) is quoted:

A recent paper indicates that two criteria are available to distinguish between shock and hemorrhage. In shock the blood becomes more concentrated, as shown by specific gravity, hemoglobin and erythrocyte count following hemorrhage, dilution of blood occurs. In shock there is widespread capillary dilatation of the viscera, congestion accompanied by edema and petechial hemorrhages following hemorrhage the tissues are anemic. The differentiation of hemorrhage and shock is of more than academic importance. It is well known that recovery follows the introduction of physiologic solution of sodium chloride into the circulation of patients suffering from the simple loss of blood. The futility of this procedure in shock has been proved beyond question. The increased permeability of the capillaries, which is a characteristic feature of shock, allows saline solution to escape readily into the tissues. Solutions containing scacia or dextrose have

(References to paper of Means, V. H. and Kennedy, P. J. Pathology of shock. Arch. Path., 1932, 37: 360.)

been found more effective than saline solutions but not so effective as transfusion of blood. Even the latter is ineffective in profound shock.

In other words, it is stated that shock is associated with an increase in the concentration of the red blood cells, with no response to the transfusion of blood and with capillary congestion and hemorrhage in the tissues. On the other hand hemorrhage is associated with a dilution of the red blood cells with a favorable response to transfusion, and with an anemic appearance of the tissues. Evidence will be presented which shows that some of these statements are erroneous.

Experiments (10) were performed with local anesthesia on dogs in which the blood pressure was gradually reduced to a low level by the slow withdrawal of blood from the femoral artery. After having produced a sustained decline in the pressure to approximately 70 millimeters of mercury, the animal was allowed to die without having further blood removed. The desired condition was to have the blood pressure remain at a low level as long as possible preceding death. Usually death occurred approximately an hour after a sustained reduction in the pressure had been obtained. Capillary congestion and hemorrhage were noted in some of the organs at autopsy. An increase in the concentration of the red blood cells occurred in a few of the experiments.

A low blood pressure of longer duration was produced in other experiments (10). The pressure was reduced by the removal of blood from the femoral artery and death was delayed by the introduction of blood by the direct method from a suitable donor. If the blood pressure rose above 70 millimeters of mercury further blood was removed. If death seemed imminent, a small quantity of blood was withdrawn from the donor and injected intravenously. In this manner the blood pressure was maintained at a low level for several hours before death occurred. No evidence that the blood was incompatible was observed. The blood pressure records in these experiments were quite similar to those that were obtained when an extremity was traumatized. The clinical picture of shock in patients was re-duplicated to a large extent

in these experiments. Apathy, pallor, a weak, thready pulse, a low blood pressure, and vomiting were observed. Dogs do not have sweat glands and hence sweating was not a part of the picture. All of the animals died despite the fact that more blood was introduced than was removed. In other words after the blood pressure remained at a low point for several hours transfusion was without benefit. An increase in the concentration of the red blood cells was found in all experiments. Capillary congestion and hemorrhage and necrosis were present in many of the tissues of the body. Particularly striking was the presence of free blood in the lumen of the intestinal tract. Previous observers have described the effects of an inadequate blood supply on the central nervous system.

Thus it is to be noted that an increase in the concentration of the blood, a negative response to transfusion and marked alterations in the tissues of the body can be produced by hemorrhage, and that they are not peculiar to traumatic shock.

In the care of patients, one rarely observes as a result of hemorrhage a low blood pressure that persists for several hours. If blood is lost to the outside from a large vessel such as the femoral or carotid artery, usually either early death occurs or the bleeding is controlled. If early death occurs it is only natural that the tissues of the body should appear anemic at autopsy. If the bleeding is controlled usually the blood volume is increased by the withdrawal of fluid from the tissue spaces into the blood stream or fluid is introduced artificially and the blood pressure rises. On the other hand, when whole blood or blood plasma are lost from many small vessels into the tissue spaces of an injured extremity, the decline in the blood pressure is slower and the duration of the low blood pressure is longer because the speed with which the fluid escapes is governed largely by the number and size of the vessels and by the relationship between the pressure in the blood vessels and in the tissue spaces. As the pressure in the blood vessels decreases and as the pressure in the tissue spaces increases the escape of fluid at the site of injury is retarded. Since the blood pressure declines slowly and

remains at a low level for a considerable time preceding death following trauma to large masses of muscle all of the tissues of the body are partially deprived of blood and oxygen during this time and alterations such as capillary hæmorrhage and congestion take place in them. Hæmorrhage from a large blood vessel is usually associated with a dilution of the red blood cells while trauma to tissues is usually associated with a concentration. In the former instance the fluid that is lost is whole blood. If the loss of blood is stopped a dilution of the remaining red blood cells occurs as the result of the passage of fluid from the tissue spaces into the blood stream. On the other hand the fluid that escapes into the spaces following trauma to large masses of tissues consists in the main of blood plasma. Undoubtedly some fluid passes from the uninjured tissue spaces into the blood stream but fluid continues to be lost at the site of injury and an increase in the concentration of the red blood cells in the vessels results.

As a result of these and other observations it seems that the local loss of fluid at the site of injury is responsible for the shock that develops following injury to large masses of muscle. It is not maintained that all or the majority of instances of shock are due to this cause. For example, the declines in blood pressure which sometimes follow intra-abdominal operations injury to the brain and the perforation of ulcers are probably brought about by different mechanisms.

It is to be emphasized that there are contributory factors that frequently play a part in the production and maintenance of shock. Food and water deprivation increase the susceptibility to shock. Exposure to cold increases the ease with which it can be produced. Just as a serious illness reduces one's ability to withstand the loss of blood similarly it lessens the amount of trauma that can be tolerated. Profuse sweating following injury reduces the volume of fluid available for the blood stream. I have observed recently (10) that the prolonged anesthetization of normal dogs by ether causes capillary congestion and hæmorrhage in many of the organs of the body. It frequently results in the escape of blood into the lumen of the intestinal tract.

These alterations diminish somewhat the loss of fluid that can be tolerated.

#### PREVENTION AND TREATMENT OF SHOCK

As regards the prevention of shock, only several of the more important points will be mentioned. The maintenance of the body temperature at as nearly the normal level as possible is exceedingly important in patients who have been injured and in those upon whom operations are performed. The patient who has been severely injured should if possible be wrapped in blankets before being transported. If the clothing is wet, it should be removed as soon as dry clothing is available. Patients who are to be operated upon should not receive drastic purgatives. This is especially important if it is necessary to restrict the intake of fluids following the operation. If a person receives a fracture of a long bone and particularly if it is the femur the part should be splinted before the patient is moved. In cases of severe injury in which the diagnosis has been made and in which damage to the brain is not suspected morphine should be given. In the presence of gross injury to an extremity the application of a tourniquet is usually the quickest method of stopping hæmorrhage. However it is very important that the tourniquet should not be left in place for a considerable time if an attempt is to be made to save the part. In the presence of a low or declining blood pressure local or gas-oxygen anesthesia is preferable to ether or chloroform or spinal. It should be remembered that a person may have lost a great deal of blood and still have an essentially normal blood pressure, but yet the loss of a slight additional quantity may result in severe shock. Rigid hemostasis and the gentle handling of tissues become even more imperative than usual under these circumstances. If the blood volume has been diminished by hæmorrhage, transfusion should be performed if possible before any operative procedure is carried out.

The principles that have been mentioned apply also to the treatment of shock. The two methods that are used most commonly in an attempt to better the condition of the patient are the giving of vasoconstrictor drugs

and the introduction of various fluids. The giving of drugs which produce vasoconstriction causes a rise in blood pressure but it is seldom sustained except in primary shock. It is important to realize that the aim in treating secondary shock is not to produce a high blood pressure but to cause an increase in the volume of the circulating blood. This is seldom accomplished by the use of drugs. When vasoconstriction is produced, the amount of blood reaching the organs may be decreased rather than increased. The ideal method of treating the condition would be to introduce into the blood stream some fluid that would remain there, thus increasing both the volume of blood and the blood pressure. Unfortunately not even blood will meet these requirements when the state of shock has existed for a considerable time.

In association with Drs Beard, Wilson and Weinstein (2), the effects on the blood volume and on the protein content of the blood plasma of introducing the various fluids that are commonly used in treating shock was studied. Special attention was devoted to the protein content of the plasma because it is the substance that attracts fluid into the blood stream and holds it there and this is what one wishes to accomplish in the treatment. The remarks here will be limited to the effects of the intravenous introduction of fluids into animals in which gross injury to capillaries had been produced. They apply to all conditions, including that produced by hemorrhage resulting from a markedly depressed blood pressure of several hours duration. The intravenous injection of solutions of crystalloids such as salt or glucose under these circumstances was associated with not only the loss of the greater part of the fluid that was injected, but also with a decrease in the protein content of the plasma remaining in the vessels. When whole blood or blood serum was introduced intravenously under similar conditions, plasma and hence proteins were lost through the capillary walls but a decrease in the protein content of the plasma remaining in the vessels did not occur since protein was present in the blood that was injected. The addition of adrenalin or pituitrin (14) to the various fluids that were injected into the

blood stream did not seem to lessen the loss of plasma.

#### A CLASSIFICATION OF ACUTE CIRCULATORY FAILURE FROM A PHYSIOLOGICAL VIEWPOINT

If the term shock is to be retained in medical literature, it is important that its meaning should be clearly defined. The word should be used in a generic sense to include a clinical syndrome which is familiar to all. The most striking features of the fully developed condition are apathy, pallor, sweating, cold extremities, thirst, a weak pulse, and vomiting.

The work of recent years has shown that this clinical picture is dependent on an inadequate blood supply to the tissues of the body. This may be brought about in several ways and since treatment depends primarily on the underlying disturbance, it is important that we classify the different types of acute circulatory failure from the physiological viewpoint.

*1 Hematogenic type.* First to be considered is the hematogenic type. The initial and the most important circulatory change is the diminution in the blood volume. Unless the initial decrease in blood volume is too great, compensatory vasoconstriction maintains the arterial blood pressure at or near the normal level. The decline in blood volume is followed by a decrease in the return of blood to the heart and hence in a decrease in the cardiac output. If the volume of circulating blood continues to diminish, the blood pressure declines even though vasoconstriction is maintained. If the blood pressure remains depressed for a considerable time, the vasoconstrictor mechanism fails and vasodilatation results. When this stage has been reached, many other factors enter into the picture and make the condition worse. Most of these factors are probably common to all types of severe shock regardless of the mechanism of the production. These include an insufficient supply of oxygen to the tissues with resulting damage, a decrease in the production of heat, an increase in the viscosity of the blood, an increase in capillary permeability, a diminution in the alkali reserve and probably the accumulation of toxic products. The important alterations are the early



ones. It is concerning the cause for the decline in blood pressure that most of the theories have been advanced.

It is with the hæmatogenic type of shock that this paper is largely concerned. Shock as a result of uncomplicated hæmorrhage is the simplest example. Shock following trauma to large masses of muscle belongs to this group if my experiments and those of Parsons and Phemister have been interpreted correctly. If the characteristics of this type are an initial decline in the blood volume, vasoconstriction, a decrease in the output of the heart before the blood pressure alters appreciably and the local loss of enough of the blood volume to account for ultimate decline in pressure then they are all met by the experiments in which the extremities were injured. The fact that the simple removal of blood in such manner that the blood pressure will remain at a low level for as long as possible, may be associated with an increase in the concentration of the blood, a negative response to transfusion and capillary congestion and hæmorrhage in the tissues, lends support to this belief.

**2 Neurogenic type** This term is used to designate the condition that is usually known as primary shock or collapse. It is more rapid onset than the hæmatogenic type. A satisfactory explanation for the conditions seems to have been offered by Goltz. The primary alteration is vasodilatation dependent on diminished constrictor tone as a result of influences acting through the nervous system. The major circulatory disturbance at first consists of a decline in blood pressure but if it remains depressed the volume of blood and the output of the heart decrease. Neurogenic shock may be brought about by agencies which influence the nervous system directly such as spinal anesthesia or trauma, or it may be reflex in origin as for example the collapse that follows a severe blow on the abdomen.

**3 Vasogenic type** Vascular dilatation may be brought about by agencies which act directly on the vessels. Histamine probably exerts the major portion of its effect in this manner. It has been shown that the administration of histamine is associated with a primary fall in the blood pressure and that

the output of the heart declines later. The shock that follows the removal of the adrenal glands probably belongs to this type.

**4 Cardiogenic type** Acute circulatory failure as a result of primary disturbance of the heart occurs very rarely. It is characterized by venous distention in contrast to the collapsed condition of veins that is found in peripheral circulatory failure. A rapid accumulation of fluid in the pericardial cavity produces this type of alteration. Shock associated with deep anesthesia by chloroform probably belongs in the main to this type.

**5 Unclassified conditions** Many different factors may enter into the production of shock that is associated with operations. Among these may be included, hæmorrhage, loss of plasma from the exposed surfaces, loss of water from the body by sweating or possibly preliminary purging, dilatation of vessels as a result of mechanical irritation and vascular reflexes, infection, anesthesia, and particularly the disease for which the operation is performed. The simple opening of the peritoneal cavity is frequently associated with a temporary decline in the blood pressure which is probably reflex in origin. The circulatory collapse that occurs following the rupture of a hollow viscus such as a perforation of a duodenal ulcer appears, because of its sudden onset to be at least partially reflex in origin. Probably many different factors enter into the production of the circulatory failure that frequently results from peritonitis. These include the loss of large amounts of fluid from the blood stream into the peritoneal cavity, the dilatation of the blood vessels as a result of the presence of irritating substances, the various actions of the toxic products of the infection and the effects of the disease that caused the peritonitis. The mechanism of the circulatory failure that occurs in pneumonia, typhoid fever and other severe infections is probably equally complicated.

Such are the various types of acute circulatory failure. They may be produced by the most diverse diseases and may be dependent on several different fundamental physiological disturbances. The eventual result is the appearance of a clinical picture which may be designated as shock.

In conclusion it is probably unnecessary to state that our information concerning many types of acute circulatory failure is still incomplete. However some definite advances have been made since Travers presented his contributions more than one hundred years ago. At least shock has been stripped of much of the mystery that surrounded it. I have not intended in any manner to belittle the views of those who have preceded us for their contributions form an integral part of our present conception of the condition. Although there is at present no satisfactory treatment for shock which has persisted for several hours, a better understanding of the underlying causes has led to a great diminution in the incidence of shock and to the more successful treatment of the condition during the early stages of its development.

## BIBLIOGRAPHY

1. BEARD and BLALOCK. Experimental shock. The composition of the fluid that escapes from the blood stream after mild trauma to an extremity after trauma to the intestines and after burns. *Arch. Surg.* 1931 xxi, 617.
2. BEARD et al. *J. Clin. Invest.* 1931 xii, 249, 267, 291, 311.
3. BICHAT. *Physiological Researches upon Life and Death*. Translated by Tobias Watkins. Philadelphia: Smith and Maxwell, 1809.
4. BILLROTH. T. *Handbuch der allgemeinen und speziellen Chirurgie von Pitha und Billroth*. Quoted by Groeningen. Erlangen 1867.
5. BLALOCK, ALFRED. Mechanism and treatment of experimental shock. Shock following hemorrhage. *Arch. Surg.* 1937 xv, 762.
6. Idem. Experimental shock. The cause of the low blood pressure produced by muscle injury. *Arch. Surg.* 1930 xx, 950.
7. Idem. Trauma to the intestines. The importance of the local loss of fluid in the production of the low blood pressure. *Arch. Surg.* 1931 xxii, 314.
8. Idem. Experimental shock. The probable cause for the reduction in blood pressure following mild trauma to an extremity. *Arch. Surg.* 1931 xxii, 593.
9. Idem. Experimental shock. The importance of the local loss of fluid in the production of the low blood pressure after burns. *Arch. Surg.* 1931 xxii, 610.
10. Idem. Unreported observations, 1935.
11. BLALOCK and BEARD. The effects of adrenalectomy on the cardiac output and blood pressure. *J. Lab. & Clin. Med.*, 1933, xviii, 941.
12. BLALOCK and BRADSHAW. Trauma to the central nervous system. Its effects on cardiac output and blood pressure. An experimental study. *Arch. Surg.* 1929, xiv, 725.
13. Idem. Distribution of the blood in shock. The oxygen content of the venous blood from different localities in shock produced by hemorrhage, by histamine and by trauma. *Arch. Surg.*, 1930, xx, 26.
14. BLALOCK, WILSON WEINSTEIN and BEARD. Loss of protein from the blood stream. Effects of the injection of solution of pituitary and of epinephrine. *Arch. Surg.* 1933 xxvi, 330.
15. BLOW ALBERT. Du Shock Traumatique. *Arch. gén. d. méd. Par.* 18 6 January.
16. BOIST, EUGENE. The nature of shock. *Am. J. Obst.* 1907 lv, 1.
17. BUCK, ALBERT H. *The Dawn of Modern Medicine*. Yale University Press. New Haven, 1920.
18. BURCH and HARRISON. The effect of spinal anesthesia on the cardiac output. *Arch. Surg.* 1930 xxi, 330.
19. Idem. The effect of spinal anesthesia on arterial tone. *Arch. Surg.* 1931 xxii, 1040.
20. CANNON W. B. *Traumatic Shock*. New York: D Appleton and Co 1923.
21. Ibid. P 135.
22. CANNON and BAYLIS. Note on muscle injury in relation to shock. *Rep. Med. Research Council*, 1919 March. No. 26 19-23.
23. CLARKE, F. LE GROS. Lectures on the principles of surgical diagnosis especially in relation to shock and visceral lesions. London: John Churchill and Sons, 1870.
24. CRILE, G. W. *An Experimental Research into Surgical Shock*. Philadelphia: J. B. Lippincott Co. 1897.
25. Blood Pressure in Surgery. Philadelphia, 1903.
26. Hemorrhage and Transfusion. New York and London: D Appleton and Co., 1903.
27. Anoci-Association (with W. E. Lower). Philadelphia: W. B. Saunders, 1915.
28. Idem. A Bipolar Theory of Living Processes. New York: The MacMillan Company 1926.
29. DANIEL, URSCHUCH, and BLALOCK. The absorption from traumatized muscles. *Surg. Gynec. & Obst.* 1935, li, 1017.
30. DAWSON W. R. *Magician and Leech*. London: Methuen and Co. Ltd. 1929.
31. DOLLEY DAVID H. The cytological analysis of shock. *J. Med. Research*, 1916, xxix, 305.
32. ERLANGER, J. GEMILL, R., and GASSER H. S. Studies in secondary traumatic shock. I. The circulation in shock after abdominal injuries. *Am. J. Physiol.* 1919 xlii, 90.
33. ERLANGER et al. *Am. J. Physiol.* 1919, xlii, 90 151 345 431 104 119.
34. ERLANGER, J. and GASSER, H. S. Studies in secondary traumatic shock. III. Circulatory failure due to adrenalin. *Am. J. Physiol.* 1919, xlii, 345.
35. FISCHER, H. Ueber den Shock. *Samm. klin. Vortr.* 1870, No. 10.
36. FORBES, A. and MILLER, R. H. Detection with the string galvanometer of afferent impulses in the brain-stem and their abolition with ether anesthesia. *Am. J. Physiol.* 1916 xl, 148.
37. Idem. The effect of ether anesthesia on afferent paths in the decerebrate animal. *Am. J. Physiol.* 1923 lxii, 113.
38. FRIEDLANDER and LENHARDT. Traumatic shock. *Arch. Surg.*, 1932 xxv 693.
39. FREEMAN N. L. Cortis and traumatic shock. *Science*, 1933 lxxviii, 217.
40. Idem. Decrease in blood volume after prolonged hyper-activity of the sympathetic nervous system. *Am. J. Physiol.* 1933, clii, 185.
41. GARRISON F. H. *An Introduction to the History of Medicine*. Philadelphia: W. B. Saunders Company 1924.
42. GOLTZ, FR. VACAS and HEHL. *Arch. f. path. Anat. u. Physiol.* 1863 xxvi, 1.

40. GOLTZ, FR. Ueber den Tonus der Gefäße und seine Bedeutung fuer die Bluthbewegung. *Arch. f. path. Anat. u. physiol.* 1854, xxix, 304.
41. GROENHOVEN, G. H. Ueber den Shock. Wiesbaden. J. F. Bergmann, 1835.
42. GRACE, SAUNDERS D. System of Surgery. Pathological, Diagnostic, Therapeutic and Operative. 5th ed. Philadelphia. Henry C. Lea, 1872.
43. HENRIKSSON, Y. ARNOLD. Acapnia and shock. I. Carbon-dioxide as a factor in the regulation of the heart rate. *Am. J. Physiol.* 1903, xii, 126.
44. HIPPOCRATES. Quoted by Ambroise Paré. *Les Oeuvres* 15th ed. p. 203. Lyon. Jean Gregoire, rue Merciere, 1664.
45. Idem. P. 214.
46. HOWELL, W. H. Contributions to medical research. Dedicated to Victor Vaughan, 1903.
47. HUNTER, JOHN. The Complete Works of Vol. 12. Edited by JAMES F. PALMER. Philadelphia. Hanwell, Barrington & Hanwell, 1841.
48. JORDAN and BLALOCK. Experimental shock. A study of the effects of the loss of whole blood, of blood plasma and of red blood cells. *Arch. Surg.* 1931, xliii, 626.
49. JORDAN and BLALOCK. Experimental shock. A study of the effects of hemorrhage, of trauma to muscles, of trauma to the intestines, of burns and of histamine on the cardiac output and blood pressure of dogs. *Arch. Surg.* 1931, xliii, 855.
50. JORDAN, FREDERICK. *Surgical Enquiries*. London. J. and A. Churchill, 1880.
51. *Journal of American Medical Association*, 1913, c, 46.
52. KEITH N. M. Blood volume changes in wound shock and primary hemorrhage. *Rep. Med. Research Council*, 1919, No. 27. March.
53. KOCKER, R. A. The effect of activity on the histologic activity of nerve cells. *J. Am. M. Ass.* 1916, lxxv, 179.
54. LARREY. *Memoirs of Military Surgery*. Translated by P. W. Hall. Baltimore. John Cushing, 1814.
55. MALCOLM, JOHN D. On the condition of the blood vessels during shock. *Lancet*, 1907, i, 497.
56. MAJOR, F. C. Shock during general anesthesia. *J. Am. M. Ass.* 1917, lxi, 37.
57. MAJOR, H. C. The peripheral origin of surgical shock. *Bull. Johns Hopkins Hosp.* 1914, xxv, 805.
58. MARSHALL-MOULLIN, C. W. Shock. The International Encyclopedia of Surgery. Edited by J. Ashurst. Vol. 4, p. 357. London, 1881.
59. MAYOTTE, E. D. Shock its nature duration and mode of treatment. (*Transactions of Surgical Society of Ireland*). *Brit. M. J.* 1870, ii, 1023.
60. Memorandum upon surgical shock and some allied conditions, issued by the Medical Research Council. *Brit. M. J.* 1917, i, 381.
61. MILLER, S. J. The nature of shock. *Arch. Int. Med.*, 1908, i, 547.
62. MITCHELL, S. WIER. Injuries of Nerves and Their Consequences. Philadelphia. J. B. Lippincott Co. 1872.
63. PARSONS and PRINGETTER. Hemorrhage and shock in traumatized limbs. An experimental study. *Surg. Gynec. & Obst.*, 1930, li, 196.
64. PRINGETTER and HANBY. Vascular properties of traumatized and bled bloods. *J. Physiol.*, 1931, lxi, 155.
65. PORTER, W. T. The effect of wall-form afferent impulses upon the blood pressure at different levels. *Am. J. Physiol.* 1907, xi, 390.
66. Idem. Fat embolism shock is not explained by embolism of the lungs. *Boston M. & S. J.* 1919, cxviii, 53.
67. PORTER, W. T., MAHER, H. K., and SWIFT, J. B. The relation of afferent impulses to fatigue of the vasomotor centre. *Am. J. Physiol.*, 1907, xi, 444.
68. PORTER, W. T. and QUINBY, W. C. Further data regarding the condition of the vasomotor nervous in shock. *Am. J. Physiol.*, 1908, xii, 900.
69. QUESN. *Rev. de chir.* 1918, lvi, 304.
70. Report of the Medical Research Council, 1919, No. 25, 120.
71. ROOPER, KEITH and PRINGETTER. Experimental shock the effect of bleeding after reduction of the blood pressure by various methods. *Surg. Gynec. & Obst.*, 1933, lvi, 6.
72. SAYOR, W. S. Collapse and the General Effects of Shock Upon the System. Holmes System of Surgery. Philadelphia. Henry C. Lea's Son and Co. 1881.
73. SEARSOLE, C. C. The pathology of shock. *Tr. Med. Soc. Pennsylvania*, 1881, p. 654.
74. SELLIS, M. G., and LYON, E. P. The condition of the peripheral blood vessels in shock. *J. Am. M. Ass.* 1909, lii, 45.
75. SMITH, M. J. Studies on experimental shock with especial reference to its treatment. *J. Pharmacol. & Exper. Therap.* 1933, xciii, 465.
76. SODERSTEDT, W. B., and GILLER, F. J. The native shock of Central Australia. London, 1890.
77. STARLING, E. H. *Arch. med. belge*, 1918, lxi, 366.
78. STANLEY, W. W., PRINGETTER, J. J., and H. M. BOTT, P. A., and PARADES, W. M. The function of the adrenal cortical hormone and the cause of death from adrenal insufficiency. *Science* 1933, lxxvii.
79. TRAVERS, BENJAMIN. An Inquiry Concerning that Disturbed State of the Vital Functions Usually Designated Constitutional Irritation. New York. H. Stevenson, 1836.
80. TULLY. Quoted by O. W. Holmes. *Medical Essays*. Boston. Houghton, Mifflin and Co., 1833.
81. TYRELL, FREDERICK. The lectures of Sir Astley Cooper on the Principles and Practice of Surgery. Philadelphia. Hanwell, Barrington & Hanwell, 1839.
82. UNDERHILL, KAPENSON, and FREE. Studies in the mechanism of water exchange in the animal organism. II. Changes in capillary permeability induced by a superficial burn. *Am. J. Physiol.* 1930, xc, 315.
83. WARREN, A. S. Traumatic lipemia and fatty embolism. *Internat. Clin.*, 1913, iv, Series 15, 171.
84. WARREN, JOHN COLLINS. Surgery, Pathology and Therapeutics. Philadelphia. W. B. Saunders Co. 1900.

OXYGEN PNEUMOPERITONEUM IN THE DIAGNOSIS AND TREATMENT OF TUBERCULOSIS OF THE GENITALIA, INTESTINE AND PERITONEUM<sup>1</sup>

IRVING F. STEIN, M.D., F.A.C.S., CHICAGO

Associate Professor of Obstetrics and Gynecology, Northwestern University Medical School and Michael Reese Hospital

IT is, indeed, fitting that here in Chicago during the celebration of A Century of Progress this Congress of Physical Therapy shall record another step forward in the diagnosis and treatment of intra abdominal tuberculosis. The surgical treatment which up to the present time had become the method of choice in the care of tuberculous peritonitis was discovered by mistake, and at the same time the use of oxygen therapy in the treatment of this condition was born. In 1872, Spencer Wells operated upon a woman for ovarian cyst but when the abdomen was opened he found instead tuberculosis of the peritoneum. In this instance cure followed the mere opening and closing of the abdomen. Wells, however, did not appreciate the significance of this result, and it was not until 1884 when Koenig advocated the surgical treatment of tuberculous peritonitis that it became a recognized procedure. The interpretation of the *modus operandi* has led in many directions, as Hertzler says the fact that there are about twenty theories advanced to explain how simple laparotomy cures tuberculous peritonitis is in itself enough to throw doubt upon the value of operation.

Lauenstein believed that the cure by laparotomy resulted from the removal of fluid and the action of light during the short exposure at operation, and Joseph Price named it the "sunshine operation." This action is definitely disproved by the puncture method various gases having been successfully used to insufflate the abdomen. Nolen used sterilized air and obtained cure. Filtered air, atmospheric air, nitrogen, and finally oxygen were successively used therapeutically. Maestri (1925) claims to be the originator of the oxygen method although there are a number of references to its adoption earlier (McGinn, A. Stein, Bainbridge). He analyzed the results of air inflation, tried nitrogen

without success (although Santorsola prefers nitrogen as he believes it is less rapidly absorbed) and finally introduced pure oxygen. He claims that oxygen has a specific action on the tubercle bacillus and on its enzymes. In his animal experiments he found that the speed of absorption of oxygen in the peritoneal cavity of rabbits gradually diminished with successive insufflations. The peritoneum after contact with oxygen does not allow organic colloids to pass through, but it has a greater than the normal permeability to crystalloids. Furthermore, ascitic fluid in contact with oxygen becomes less alkaline and has increasing oxydizing action. The method of air insufflation was initiated by von Mosetig Moorhof in 1892, the curative action of the injected air, however, was first attributed by Floris to its oxygen content. Bainbridge believes that oxygen acts as a germicide. Silvestri, in 1911, concluded as follows: (1) the introduction of atmospheric air into the pleural and peritoneal cavities is the most efficacious method of treatment for tuberculous serositis, (2) the quantity of air insufflated should correspond to that of the fluid removed, (3) atmospheric air not only does not cause any inconvenience, not only does not contaminate the serous cavity but is shown to be far more effective than filtered or sterilized air, (4) this method is indicated in tuberculosis of any serous surface wherever found.

Norris disagrees that the admittance of air into the abdomen is the reason for cure of patients operated upon, but believes that the removal of fluid is the chief beneficial agent. It is commonly known however that fluid increases rapidly after tapping unless air or oxygen is insufflated and furthermore how does Norris explain the cures of patients operated upon or insufflated by puncture in whom there was no demonstrable fluid?

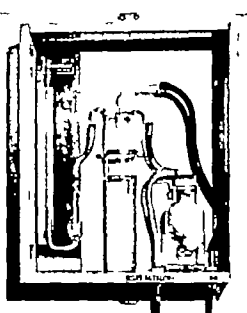


Fig 1 Needle used for transabdominal pneumoperitoneum and insufflation apparatus

Norris apparently ignored the literature on oxyperitoneum when revising his monograph (1931) while Hertzer's valuable book on *The Peritoneum* published 9 years earlier quotes McGlenn as using oxygen insufflations for tuberculous peritonitis in 1908. In his chapter on genital tuberculosis in Curtis *Obstetrics and Gynecology* 1933 Norris says "In some instances the careful injection of oxygen into the peritoneal cavity may prove of value. There are numerous other contributions in the medical literature on oxygen therapy in tuberculous peritonitis between 1925 and the present time."

If the value of laparotomy lies in the exposure of the tissues to oxygen then it is quite logical that the simple introduction of pure oxygen or air should replace the surgical exploration. Puncture is simply and safely done and inflation of the abdomen with any where from 100 to 1000 cubic centimeters of gas requires at most 24 to 48 hours hospitalization. In addition to sparing the patient the pain and danger of laparotomy there is a great economic gain in utilizing the puncture method. Furthermore the genital structures may be conserved in tuberculous salpingitis much is to be gained and nothing lost by

giving the more conservative method a trial. If no beneficial effects are noted in 10 to 14 days the injection may be repeated, and if no improvement occurs, laparotomy may still be performed the gas having done no harm.

#### DIAGNOSTIC PNEUMOPERITONEUM IN GENITAL TUBERCULOSIS

It is commonly acknowledged that the diagnosis of tuberculous salpingitis—the commonest cause of tuberculous peritonitis—is difficult to establish. Occurring in from 5 to 10 per cent of inflammatory lesions of the fallopian tubes, and a common cause of salpingitis in the virgin it frequently escapes recognition until exploration of the abdomen and pelvis is made. It may be suspected however after a careful study of the patient's history and the proper evaluation of abdominal and bimanual examination. Laboratory aids are usually required in addition to establish the correct diagnosis.

As in the case of obscure pelvic conditions in the general run of gynecological material, so also in pelvic tuberculosis the employment of diagnostic pneumoperitoneum is of decided value in arriving at a correct diagnosis without recourse to laparotomy. We have pre-



Fig. 2. Pneumograph after pneumoperitoneum. The roentgenogram reveals normal uterus, ovaries, and tubes.



Fig. 3. Author's combined method of pneumoperitoneum and uterosalpingography. Hypoplastic uterus, normal ovaries and patent tubes.

viously stated (23, 24) that in our service we have practically eliminated the resort to exploratory laparotomy in our pelvic surgery since utilizing diagnostic pneumoperitoneum and we have employed the method in well over one thousand cases within the past 10 years.

In suspected pelvic tuberculosis, oxygen is used in place of carbon dioxide because of its therapeutic as well as its diagnostic value in this condition. When tuberculosis is present often involving the pelvic structures, peritoneum, and intestines repeated oxygen insufflations are used. We have encountered no serious accidents in performing transabdominal puncture and believe that if the same degree of caution is exercised as in the puncture of other body cavities i.e. pleura, spinal canal, the objections cited by those who fear to use it may be easily overcome. By means of diagnostic pneumoperitoneum alterations in the size, shape, density, and relationship of the various pelvic organs and especially the presence or absence of adhesions may be demonstrated clearly in the X-ray film. Numerous contributors besides ourselves have attested to this observation. After one has gained an experience in interpreting the normal pneumographic findings in pelvic roent-

genography pathological conditions are more or less readily recognized with a high degree of accuracy.

It is usually sufficient to insufflate the abdomen with a liter of oxygen to demonstrate the presence of pelvic tuberculosis, iodized oil may also be employed in combination with oxygen insufflation when it is desirable to demonstrate the relationship of the uterine cavity and fallopian tubes in a large pelvic mass (as in author's Case 1). The combined method has previously been discussed by us (24). The fallopian tubes in tuberculosis are usually greatly enlarged, tortuous and thickened so that they cast an unusually dense shadow on the roentgen film and they are usually patent. Sometimes calcium deposits in the tube wall are demonstrable. Dense intestinal adhesions are commonly found particularly in the plastic variety which are readily recognized on the film. A moderate amount of serous exudate is no contra indication, if large amounts are present, tapping should precede the introduction of oxygen. As to the range of the use of oxygen insufflations in various types of intra-abdominal tuberculosis the following briefly stated case histories will best serve as illustrations.



Fig 4

## TECHNIQUE

The procedure is exceedingly simple and differs in no way from that of the trans abdominal pneumoperitoneum with carbon dioxide used for gynecological diagnosis (25). It is advisable that about an hour before treatment the bowels be emptied by means of a cleansing enema. One half hour before morphine sulphate (alone or combined with scopolamine hydrobromide) should be administered the dose depending upon the age, condition and size of the patient. For the average adult who is in fairly good condition  $\frac{3}{4}$  grain of morphine may be used, combined with  $\frac{1}{150}$  grain of scopolamine. The bladder should be empty just before treatment. The skin of the lower abdomen is prepared with alcohol followed by a 2 per cent mercurochrome solution which is allowed to dry. A rather firm inflexible needle of 3 inches in length and fitted with a stylette is introduced through the abdominal wall no local anesthetic being required. The point of introduction is usually one inch to the left of the umbilicus and slightly below that level. The needle is held vertically between the thumb and third finger at right angles to the skin and is introduced into the peritoneal cavity by means of pressure of the forefinger on the stylette. Three resistances are met first, the

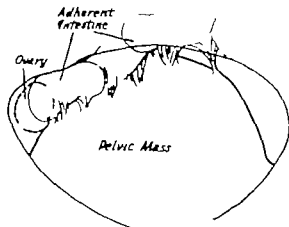


Fig 4 Pelvic tuberculosis. Oxygen pneumoperitoneum. Large pelvic mass with intestinal adhesions. (Authors Case.)

skin second the aponeurosis, and third the more sensitive peritoneum. After a brief experience one can readily tell whether or not the needle has entered the peritoneal cavity from the sensation experienced when a cavity is punctured. The unimpeded flow of the gas evidenced by a low stationary manometric reading gives assurance of intraperitoneal entry. The needle is attached to the oxygen insufflation apparatus by means of rubber tubing and an adaptor. The apparatus ordinarily used for Rubin patency test (Fig 1) of the fallopian tubes is fully adequate an oxygen tank supplanting that of carbon dioxide. If fluid is present, about a liter may be removed by trocar and the latter used for insufflation from one-half to the same amount of oxygen being introduced as that of fluid evacuated. A liter of oxygen produces little discomfort from distention and is usually a sufficient dose. The needle is quickly withdrawn and with needle puncture no dressing is required. The patient is kept flat on the X-ray table the same position being maintained during transportation back to bed, to prevent shoulder pain from gas entering the right subdiaphragmatic space. (The procedure can also be carried out at the bedside.) Shoulder pain may be relieved by elevating the patient's hips with a pillow or by raising the foot of the bed for a few hours. Within 48 hours all signs of oxygen have usually disappeared and probably repeated injection

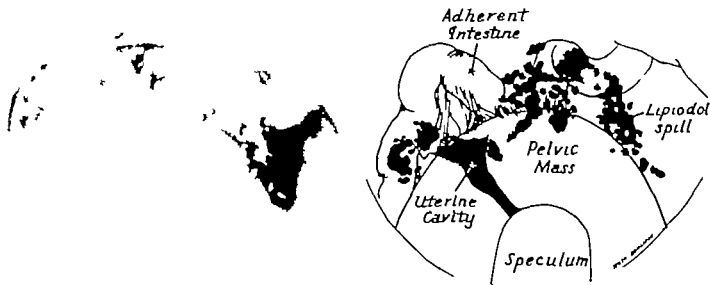


Fig. 5 Combined oxygen pneumoperitoneum and uteroculpingography (Case 1) 9 days after first injection.

could safely be made at this time. Those who have used the method have repeated insufflation in from 4 days to 2 weeks. We recommend weekly insufflations of about one liter each, the number of doses depending upon the results obtained. It is our practice to keep all patients in bed 18 to 24 hours after every pneumoperitoneum treatment whether diagnostic or therapeutic.

Early in the treatment of tuberculosis of the peritoneum the patient is usually hospitalized and in bed. When improvement sets in and temperature is normal 48 hours' bed rest after each treatment should suffice.

#### INDICATIONS

Therapeutic oxypertoneum is applicable to children and adults alike, and although most of the work has been done on women its use should be extended to men with tuberculous peritonitis. The patient should be in fairly good physical condition moribund patients are not suitable for this method. There is some question whether introduction of the needle can be safely made in the plastic form of tuberculosis, in grave pulmonary tuberculosis and advanced ulcerative intestinal tuberculosis the method is contra indicated. It is usually advisable to wait until acute symptoms have subsided and the temperature is low before starting oxygen insufflation as a febrile reaction for a day or two has been observed by some physicians

who have employed this method of treatment. In our cases this did not occur. Pregnancy is regarded by Lucherni as a contra indication to insufflation. During the first 3 months of pregnancy however when the uterus is not likely to be traumatized by puncture there is no harm in small, repeated oxygen insufflations. It may be emphasized here that pregnancy favors the development of tuberculous peritonitis. Kelly found 28 per cent of his series of pelvic tuberculosis dating from child birth.

#### CASE REPORTS

It is not the purpose of this paper to cite all the case reports in the world's literature on oxygen therapy in pelvic tuberculosis, a sufficient number will be abstracted however to exemplify the beneficial effects of this method.

*Case 1.* Uses Kuesse's apparatus for oxygen insufflation and injects slowly. He controls arterial tension and the cardiac condition. He introduces half as much gas as liquid evacuated in the exudative variety. A few insufflations are considered enough. He recommends the additional use of 10 to 12 grains of calcium chloride daily to prevent reappearance of fluid.

A boy aged 17 years, previously healthy, took ill with influenza. He had fever and a dry cough for 2 months and as improvement set in hardness and swelling of the abdomen were noted. Tuberculous peritonitis was diagnosed. Climatic therapy and dietetic measures failed. Laparotomy was done and while healing was uncomplicated fever and abdominal swelling continued. There was also a hydro-thorax. Hemoglobin was 52 per cent, and the red blood count was 3,347,000. After the removal





Fig 4

## TECHNIQUE

The procedure is exceedingly simple and differs in no way from that of the trans-abdominal pneumoperitoneum with carbon dioxide used for gynecological diagnosis (25). It is advisable that about an hour before treatment the bowels be emptied by means of a cleansing enema. One half hour before morphine sulphate (alone or combined with scopolamine hydrobromide) should be administered the dose depending upon the age, condition and size of the patient. For the average adult who is in fairly good condition  $\frac{3}{4}$  grain of morphine may be used combined with  $\frac{1}{150}$  grain of scopolamine. The bladder should be empty just before treatment. The skin of the lower abdomen is prepared with alcohol followed by a per cent mercurchrome solution which is allowed to dry. A rather firm inflexible needle of 3 inches in length and fitted with a stylette is introduced through the abdominal wall no local anesthetic being required. The point of introduction is usually one inch to the left of the umbilicus and slightly below that level. The needle is held vertically between the thumb and third finger at right angles to the skin and is introduced into the peritoneal cavity by means of pressure of the forefinger on the stylette. Three resistances are met: first, the

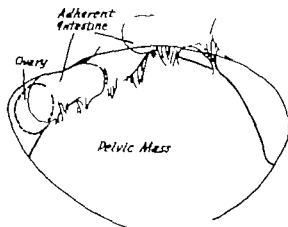


Fig 4 Pelvic tuberculoz. Oxygen pneumoperitoneum. Large pelvic mass with intestinal adhesions. (Author's Case)

skin, second the aponeurosis and third the more sensitive peritoneum. After a brief experience one can readily tell whether or not the needle has entered the peritoneal cavity from the sensation experienced when a cavity is punctured. The unimpeded flow of the gas, evidenced by a low stationary manometric reading gives assurance of intraperitoneal entry. The needle is attached to the oxygen insufflation apparatus by means of rubber tubing and an adaptor. The apparatus ordinarily used for Rubin patency test (Fig. 1) of the fallopian tubes is fully adequate, an oxygen tank supplanting that of carbon dioxide. If fluid is present, about a liter may be removed by trocar and the latter used for insufflation from one half to the same amount of oxygen being introduced as that of fluid evacuated. A liter of oxygen produces little discomfort from distention and is usually a sufficient dose. The needle is quickly withdrawn and with needle puncture no dressing is required. The patient is kept flat on the X-ray table the same position being maintained during transportation back to bed, to prevent shoulder pain from gas entering the right subphragmatic space. (The procedure can also be carried out at the bedside.) Shoulder pain may be relieved by elevating the patient's hips with a pillow or by raising the foot of the bed for a few hours. Within 48 hours all signs of oxygen have usually disappeared and probably repeated injection

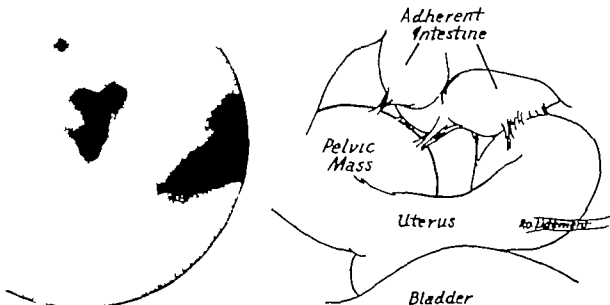


Fig. 7 Oxygen pneumoperitoneum 4 months after treatment gained 19 pounds. (Case 1)

culous peritonitis. Four oxygen insufflations of 4 liters each 3 to 5 days apart were given. Recovery followed. (The patient was operated upon for an ovarian malignancy some years later the sections revealing *Bacillus tuberculosis*.)

**Case 2** A child 11 years old had exudative tuberculous peritonitis. Ten oxygen insufflations were given after the removal of fluid there was a marked improvement.

Stein uses far greater quantities of oxygen (sometimes 5 or 6 liters) than any other worker in this field whose work is reported. It is doubtful whether such large quantities are ever indicated or advisable inasmuch as good results have been recorded from the insufflation of even very small amounts (100 to 300 cubic centimeters) of oxygen or air. The dose of 500 cubic centimeters in children and of 1 liter in adults is well borne and appears sensible to us.

*Scott and Gleeden* report 3 cases of intestinal tuberculosis favorably treated by oxyperitoneum. The following is illustrative

A male aged 22 years, had abdominal pain and diarrhea for 6 months. Fifteen injections of 400 cubic centimeters of oxygen at 10 day intervals were given. There was a complete subsidence of symptoms.

They conclude that the treatment is simple and harmless that it relieves distressing symptoms of the ulcerative type of tuberculous enteritis, and if treatment is begun early it may effect a cure.

*Purves and Bilcliffe* do not feel that the results are as good as reported by others. This opinion may be due to a poor selection of subjects for the treatment. They report 3 cases 2 of whom died, and 1 was greatly improved by oxygen insufflation.

**Case 1** Patient had plastic peritonitis with ob-

structive symptoms. Five oxygen insufflations were given. The patient was observed over a period of 1 year. Two relapses occurred. Result much improved.

**Case 2** Patient had advanced pulmonary tuberculosis (a contra indication to oxygen insufflation). After one injection the patient died.

**Case 3** The patient was diagnosed as a plastic peritonitis. Two insufflations were given but patient died from fecal fistula.

*L. B. Hudson* At laparotomy a tuberculous peritonitis was found in a colored woman. Wassermann reaction was 3 plus. Several intraperitoneal oxygen insufflations were made with great benefit.

*Nelson Mincer* The patient had an exudative tuberculous peritonitis and pulmonary tuberculosis. Three air insufflations were given 2 and 4 days apart, injecting 1500, 900 and 200 cubic centimeters of air after the removal of 1 liter one-half liter and another half liter of fluid. After 1 month all fluid had disappeared and the air absorbed. The condition of the patient was good.

*H. D. Meeker* reports a case cured for 4 years after a single oxygen insufflation following laparotomy in a 10 year old boy with tuberculous peritonitis.

*Von Moosling Moorhof* (1893) The patient observed had a tuberculous epididymitis and peritonitis, abdominal fluid was removed and air was injected reported a cure.

*Nolen* (1893) reported 3 cases cured by air injections, one of which was a child with advanced intestinal tuberculosis.

*Jacobaeus* reported 5 cures in 6 cases of tuberculous peritonitis with air insufflation.

*E. Rost* (1920) reported great improvement in 3 cases after oxygen insufflation.



Fig. 8. Tuberculous salpingitis. Oxygen pneumoperitoneum. (Author's Case 2)

Hall and Loiseleur report 3 cures and 3 failures with air insufflation. The failures are explained by active tuberculous foci elsewhere in the body. The 3 successful cases were followed up for a year: no ascites or adhesions formed. They believe that the results are equally as good after a single insufflation as when repeated treatments are given.

Haves reports successful use of oxygen following relapse after laparotomy. He reports 10 cases in all only one of which, seen *in extremis*, died.

Mason reported 3 successful cases of oxygen insufflation from Mayo clinic after failure of laparotomy to cure.

#### AUTHOR'S CASE REPORTS

**CASE 1.** E. P. single girl, aged 19 years, was admitted to the gynecological service at Michael Reese Hospital on June 7, 1927. She had been operated upon 5 years previously for tuberculous peritonitis, and had been tapped several times since. The present illness began 7 weeks before admission with acute abdominal pain following an evening of dancing (during a menstrual period). This condition was first diagnosed as appendicitis, which subsided somewhat, but pain recurred every day or so. The pain again became severe 2 days before admission. Her past and family history were unimportant except as stated. Menses were always irregular and painful. Upon examination a median laparotomy scar was seen. The abdomen was distended and doughy, but no rigidity was present. Soft masses were palpable in both lower quadrants, and were slightly tender. Rectally a very tender hard mass filled the entire true pelvis. Tuberculous peritonitis involving the pelvic structures was diagnosed and medical management was instituted: bed rest, soft diet, quartz lamp therapy and medical



Fig. 9. Tuberculous salpingitis. Oxygen pneumoperitoneum. Calcification in tube and ovary. (Author's Case 6)

diathermy. Her temperature which was 103.2 degrees on admission ranged from 98.6 to 100.2 degrees next day and continued so for a month. Her hemoglobin was 70 per cent, red blood count, 3,100,000, white blood count, 9,200 and sedimentation time was 18 minutes.

After 1 month on this management, the status was quite unchanged except that the sedimentation time rose to 38 minutes. With the rotation of service, the patient came under the author's care. Examination on July 7, 1927 revealed a pale, thin girl with a large, adherent pelvic mass extending into both adnexa and involving the uterus. The same day 1350 cubic centimeters of oxygen was introduced using our usual (23) transabdominal technique and a pneumogram taken in the prone, partial knee-chest posture. The films (Fig. 4) revealed a large, dense mass with loops of bowel definitely adherent. Four days later the mass was found to be somewhat more mobile and slightly smaller; the general condition of the patient definitely improved and there appeared still to be some oxygen in the peritoneal cavity. The temperature dropped to normal on the sixth day after insufflation and remained so. On the ninth day the patient had gained 2 pounds in weight, her temperature was normal, and the sedimentation rate was 33 minutes. Hemoglobin was 80 per cent, red blood cells, 4,730,000, white blood cells, 9,600. On July 16 a second oxygen insufflation of 1000 cubic centimeters was given and was combined with an intra-uterine lipiodol instillation for further identification of the uterus and tubes in the mass. Films (Fig. 5) taken as above showed the mass slightly smaller; the uterine cavity displaced to the right, and both tubes patent permitting free intraperitoneal spill. (This is characteristic of tuberculous salpingitis.)

July 19, 12 days after the first oxygen insufflation, the patient was so well that hospitalization was no

longer needed. She was discharged with instructions to report at the outpatient clinic. On August 7, the patient reported that she felt well had gained 5 pounds in 2 weeks, and that her temperature was normal she was working daily. She was given 1250 cubic centimeters of oxygen intraperitoneally and films showed reduction by one-half of the pelvic mass (Fig 6). Sedimentation time was 1 hour and 30 minutes. On November 7 she had gained 12 pounds since her last treatment 3 months previously. One liter of oxygen was insufflated (Fig 7). On May 24, 1928, she returned to the hospital for check up examination. She states that she has had no pain and that her previously irregular menses are now normal, also that the dysmenorrhea is cured. She gained 19 pounds in the 10 months since oxygen treatment was begun. Oxygen, 1000 cubic centimeters, was given chiefly for the purpose of obtaining a pneumogram, as the patient appeared quite healthy and the pelvic organs appeared normal to palpation. The films revealed only evidence of adhesions. On October 25, 1928, examination revealed the uterus as small, fixed, and retroverted. No adnexal masses were palpable. February 19, 1931, the patient felt well and asked whether marriage was advisable. The pelvis was negative except for a fixed retroversion.

On May 18, 1933, 6 years after oxygen therapy was begun, the patient is entirely well, has been working steadily for the past few years. The uterus is small, firm and there is a third degree retroversion. The adnexa are negative. Cure has been established and maintained for 5 years since the last oxygen insufflation.

**CASE 2:** A. G., aged 32 years, married 2 years, was apparently perfectly well until January, 1929, when she sought the author's advice because of childlessness. A small, fixed retroverted uterus and no adnexal pathology were recorded. The cervix which was found to be eroded was treated by linear cauterization. 2 weeks later a pelvic mass developed and patient had a fever. Her husband a physician, made a diagnosis of pelvic abscess. During the next few months, the cul-de-sac was drained through the vagina four times by other physicians.

Continuous fever, nausea, and vomiting, loss of weight, weakness, and a purulent, caseous discharge persisted until July 7, 1929, when the patient was admitted to Michael Reese Hospital on the author's service. The diagnosis was then made of tuberculous salpingitis and on July 10, 1250 cubic centimeters of oxygen was insufflated into the abdomen for diagnostic and therapeutic purposes. Blood cultures and cultures from the suppurative vaginal sinus were negative. The pneumogram (Fig 8) revealed a large uterus, a thickened and calcareous left tube and an indefinite right adnexal involvement. The report of Dr. R. A. Arens, roentgenologist: "Transabdominal (oxygen) pneumoperitoneum discloses a large uterine mass almost entirely to the right of the midline. The uterine fundus appears smooth and round but larger than the average.

The left adnexa appears much increased in size, the tube being tortuous. The right tube is not seen. There also appear to be numerous adhesions in the pelvis. The films disclose the typical appearance of a salpingitis (left). From the peculiar density of the tube, tuberculois must be considered.

The diagnosis of a right tubo-ovarian abscess (mixed infection) complicating tuberculous salpingitis was made. Oxygen insufflation (1000 cubic centimeters) was repeated on July 14. Each insufflation was followed by a day of lower temperature and apparent improvement and then by a resumption of the septic course. An operation was deemed imperative for removal of tubo-ovarian septic mass.

Operation on July 22 included a right salpingo-oophorectomy for large tubo-ovarian abscess, appendectomy, separation of adhesions and vaginal drainage, under spinal anesthesia. Blood transfusion was given.

When the abdomen was opened, the right adnexa were found to be involved in a tubo-ovarian abscess 6 by 7 centimeters in diameter anterior and to the right of the uterus. The appendix was adherent to the mass and about one-half inch of the tip of the appendix was buried in the abscess wall. The small gut was adherent to the mass and about the area of adherence many small tubercles were seen on the bowel wall. The left tube was thick, tortuous and adherent to the bowel. Tubercles were also seen on the intestine at this place and on the left tube. The adhesions were separated, but the left tube and ovary were conserved with the hope of restoration. The mass on the right and the appendix were removed, and the large cavity in the right pelvis was packed with iodoform gauze, the end of which was led into the vagina for drainage. Five hundred cubic centimeters of whole blood was transfused from the patient's brother before she was removed from the operating table. Typical tubercles were found on microscopic examination on the wall of the ovary and tube, and an acute (not tuberculous) purulent appendicitis. The postoperative course was satisfactory for 1 week when, after the gauze drain was removed *per vaginam* a rectovaginal fistula was discovered. On August 8, 1929, an oxygen insufflation of 1000 cubic centimeters was made. A blood transfusion of 500 cubic centimeters was given on August 22. The patient continued to run a temperature to 102 degrees, a pulse of 104 and respirations of 22. The abdominal wound had healed by primary intention. Drainage from the fecal fistula had temporarily stopped. Rectal and vaginal examination on August 27 revealed no masses palpable in the pelvis, no evidence of fistula, and a soft abdomen. Consultation with Drs. Solomon Strouse and A. H. Curtis was had and the patient was advised to seek a change in climate. The patient left the hospital August 10, 1929, somewhat improved but weighing 103 pounds. The rectovaginal fistula had reopened and was discharging. After 5 months in Albuquerque, New Mexico, she had gained 20 pounds and appeared in the best of health.

June 3, 1930 patient was in good health and weighed 135 pounds. The uterus was movable. No palpable enlargement of the left tube was noticeable. There was a small area of granulation posterior to the cervix. November 20, 1930 her general condition was excellent, weight 145 pounds. The uterus and left adnexa were normal to palpation. Cervix and vaginal vault were clean. On August 28, 1933 according to a telephone report the patient was feeling perfectly well. Menstruation was regular. Her weight was up to 165 pounds which she voluntarily reduced to 145 pounds.

CASE 3 (Courtesy of Dr M. L. Leventhal) Michael Reese Hospital. H. P. aged 32 years, single hospital technician. Patient complained of pain in both lower quadrants for 5 to 6 months, with nausea, vomiting, and temperature 103 degrees during attacks. Diagnostic pneumoperitoneum revealed a large cystic mass in the left half of the pelvis, with bowel adhesions to the uterus and the right adnexa. Operation was done on January 31, 1931 for left ovarian dermoid and chronic pyosalpinx. Both tubes and an ovarian dermoid (15 by 15 centimeters) were removed. A small amount of serous fluid was present, and several small tubercles were noted on the tubes, bladder peritoneum, and broad ligaments. The report of the pathologic laboratory was acute and chronic tuberculous salpingitis, dermoid cyst of ovary. February 28, 1931, examination showed the uterus to be enlarged and tender.

March 6, 1931 oxypentoneum—1 liter.

May 14, 1931 uterus small, anteverted, partially mobile. Tender mass was noted in left. (Adhesions?) Oxypentoneum 1 liter.

May 27, 1931 still has tender mass adherent to the uterus on the left. General condition was greatly improved.

CASE 4. (Courtesy Dr R. A. Reis) Michael Reese Hospital, February 7, 1932. Girl, aged 15 years, student, complained of pain in the lower abdomen and chest for 3 months. For the past month she had had night sweats. She had lost 18 to 20 pounds in 6 months. Meneses began at 13 years and were regular until 8 months ago since which there has been an amenorrhea.

Recto-abdominal examination revealed the cervix intact, uterus normal in size, erect, firm, tender and fixed. Diagnosis of probable tuberculous salpingitis was made. An oxygen pneumoperitoneum for diagnosis and treatment was recommended. One liter of oxygen was used. The patient was readmitted March 31, 1932 for oxygen therapy. She had gained 3 to 4 pounds since her last treatment, and had night sweats no longer. One thousand cubic centimeters of oxygen was insufflated by transperitoneal route.

Examination on September 5, 1933. Patient has had no temperature or night sweats since treatment. She has gained 13 pounds in weight, has no pain, menstruation is normal. Bimanual examination showed that except for a small induration in the left parametrium, the uterus and adnexa are negative. Cure has been of 1 year 7 months' duration.

Two additional patients with tuberculous salpingitis have been treated by the author with intraperitoneal oxygen therapy but records are incomplete concerning their subsequent course and the results obtained (Fig 9 illustrates Case 6).

The object in presenting this subject at this time is to call to the attention of the medical profession of a safe and simple method of diagnosis and treatment of tuberculous salpingitis which has almost escaped general notice. We have cited briefly 64 cases of intra-abdominal tuberculosis from the literature—an incomplete list, to be sure and have reported 6 additional cases. Two of these represent cures of 4 and 5 years, respectively. In utilizing oxygen therapy one must not lose sight of the other factors so valuable in the care of the tuberculous patient, namely rest, climate food and tonics as indicated, and surgery when the condition is complicated by mixed infection. It is evident from some of the case reports cited that intraperitoneal oxygen insufflation is valuable in intestinal tuberculosis and various forms of tuberculous peritonitis if used in the early stages. Terminal infections, moribund patients, or those with advanced pulmonary disease are unsuited for this method.

Whenever tuberculous salpingitis is suspected it is advisable to utilize oxygen pneumoperitoneum for diagnostic purposes, the films rendering valuable aid in recognizing the pathology. The oxygen at the same time serves a double purpose being a valuable therapeutic agent. This is readily appreciated by those who employ the method as the patient shows prompt evidence of improvement. Temperature falls to normal in a few days, pain is less, the patient feels stronger and begins to gain weight at once. In some instances a single insufflation is enough as reported by Lucherni. In others repeated doses may be required as indicated by the patient's course.

#### SUMMARY

Oxygen pneumoperitoneum is recommended in tuberculous peritonitis whether primary or of genital or intestinal origin. It is of value for diagnosis chiefly in tuberculous salpingitis, and in intestinal adhesions in the pelvis. It may be combined with the use of iodized

oil instillation when one desires to visualize the uterine cavity and fallopian tubes. The tubes are usually patent in tuberculous salpingitis. The insufflation is used both diagnostically and therapeutically, the method of transabdominal puncture is simple and safe.

Sixty-four cases of therapeutic pneumoperitoneum are cited from the literature and six additional cases are reported to attest the value of oxygen pneumoperitoneum in intra-abdominal tuberculosis. We urge that all patients be given oxygen insufflations as a therapeutic test before being subjected to laparotomy.

## BIBLIOGRAPHY

1. BAINBRIDGE, W. S. *Am. J. Surg.*, 1913 xxvii, 364 1923, xxxvii, 52.
2. CUKET, O. P. *Semana méd.*, 1926 I, 1263.
3. HAYES, E. W. *Lancet*, 1924, xlii, 571.
4. HEINTZLER, A. E. *The Peritoneum*. St. Louis: C. V. Mosby Co., 1919.
5. HUDSON, L. B. *Surg. J.* 1927 xxxiii, 138.
6. JACOBAEUS. *Ueber Laparo. und Thorakopy* 1913, lvii, 73.
7. KELLY, H. A. *Operative Gynecology* 1914.
8. KOENIG, F. *Centralbl. f. Chir.*, 1884, xi, 81.
9. LAURENCE. Quoted by Maynard. *Abdominal Tuberculosis*, p. 310 Philadelphia, 1908.
10. LUCHINI. *Policlin.* 1927 xxxiv, 1281.
11. MAESTRINI, D. *Riforma med.* 1925, xii, 827 1926 xiii, 892.
12. MCGILVER, J. *New York M. J.*, 1908 lxxxviii, 359.
13. MEYER, H. D. *Int. Surg.* 1912 xiv, 247.
14. MEYER, N. *Virginia M. Month.*, 1926 lili, 157.
15. VON MONTT-MOORHOF. Quoted by Maestrial.
16. MOUNT, H. T. B. *Canadian M. Ass. J.* 1931 xxv, 509.
17. NORRIS, C. C. *Gynecological and Obstetrical Monographs*. Vol. xi. New York: D. Appleton & Co. 1931.
18. PURVES and BILCLIFFE. *Brit. M. J.* 1924, I, 906.
19. SANTORSOLA, D. *Policlin.*, 1927 xxxiv, 636.
20. SCOTT and GLENN. *Atlantic M. J.*, 1925, xxix, 183.
21. SILVERSTEIN, T. *Riforma med.*, 1926 xii, 1105.
22. STEIN, A. *J. Am. M. Ass.*, 1922 lxxviii, 718.
23. STEIN, I. F. Pelvic diagnosis by roentgen visualization. *Surg. Gynec. & Obst.* 1932 lv, 207, *J. Michigan State M. Soc.* 1931 xxx, 675. *Am. J. Obst. & Gynec.* 1931 xxi, 671.
24. STEIN, I. F., and ARON, R. A. Visualization of the pelvic viscera. *Radiology* 1930, xv, 85.
25. Idem. *Pneumoperitoneum in gynecology*. *Radiology* 1926, vii, 326. 1927 viii, 494. 1929, xii, 341.
26. TREMITTERE, S. *Riforma med.*, 1926 xiii, 561.
27. WEIL and LOISELLEUR. Quoted by Tremittere.
28. WELLS, SPENCER. *Ovarian and Uterine Tumors*. London, 1873.

## THE X-RAY IN THE STUDY OF THE CATGUT LIGATURE

PAUL F. ZIEGLER, M.S., AND GEORGE L. CLARK, Ph.D., URBANA, ILLINOIS

From the X-ray Research Laboratories, Department of Chemistry, University of Illinois

MANY obscure ancient writings indicate that the idea of ligating vessels with cords was age old when Galen in the first century described the use of silk and catgut for the purpose. Recorded research in the art appears periodically from that time on. One of the important contributions was that of Ambrose Paré (1517-90) who standardized on the systematic use of the ligature in operations instead of actual cautery.

The first detailed research on absorption is sometimes credited to P. S. Physick, a professor of surgery in Philadelphia. About 1816 he demonstrated the superiority of catgut over flax or silk for ligating due to its disappearance in the wound. His experiments were started on the horse and were later transferred to humans. About 30 years later this work was greatly amplified by Luigi Porta who occupied the chair of surgery at Pavia. Porta described the results of 600 experiments on 270 animals using catgut silk, hair and hemp as ligatures.

Despite these scattered early experiments, however, research in the field really began with Joseph Lister (1869). It was Lister's paper that first referred to the use of antiseptic catgut and it was the opening gun of a tremendously active period in surgical gut research that has extended right down to the present time.

As was natural, the trend of the research following Lister's work was in the direction of sterility and for many years the literature was crowded with papers on this subject.

All the while the use of catgut in surgery was increasing by leaps and bounds and commercially manufactured gut began to replace the home made article of the surgeon. With the advent of the manufacturer new research was introduced into the picture, which work, though largely unpublished, has been of inestimable value to the surgical profession.

Processing techniques, sterilizing techniques and exact tests on products have all

been rather thoroughly covered by the better ligature manufacturers. In addition several manufacturers have sponsored research programs at medical schools on subjects pertaining to the use of catgut in surgery.

All of this research however has dealt with the macro aspects of the ligature. After reaching a certain point, further knowledge of the product had to await the development of research tools and techniques that permitted examination of the ultimate structural characteristics of these protein fibers.

## A NEW METHOD OF STRUCTURAL STUDY OF SUTURES

Our knowledge of the chemistry of proteins has been decidedly fragmentary and certainly definite information as to how protein molecules build themselves into solid animal tissues so as to account for complex behavior is almost entirely lacking. The microscope has been useful in disclosing gross structural features. By splitting up collagen fibers such as those which constitute catgut sutures, by means of swelling experiments it has been demonstrated that there are fiber bundles, built up from 5 to 10 fibers and each fiber is built up from about a hundred fibrils. These tiny fibrils are the real collagen units and yet the microscope is able to say nothing as to the still smaller and more fundamental units which comprise the fibril.

It is obvious that the desired properties in sutures and ligatures of highest quality reside in structural units which are below the resolving power of the microscope. The polarizing microscope indicates the anisotropic nature of the collagen fibers but there is little or no differentiation possible on the basis of quality. Therefore, information on the ultimate fine structure of these protein materials must be sought by other methods. The X-ray has provided a method for studying these structures and one of the newest research techniques is that of X-ray diffraction.

The X ray diffraction method enables the examination of ultimate structure of materials in the sense of a supermicroscope. Since the X ray wave lengths employed are only  $1/6000$  as long as yellow light, and both the X ray and light are diffracted by suitable gratings, the range of subdivision detected is at once indicated. All crystalline substances serve as three-dimensional diffraction gratings for the X ray, because the atoms and molecules lie upon parallel planes which are spaced apart at distances comparable with the X ray wave lengths. The diffraction pattern obtained for any crystalline substance depends, of course, on the arrangement of ultimate building units characteristic of the substance in question. Consequently, the pattern can be interpreted in terms of the actual ultimate constitution and fine structure of any material. The steps in such an interpretation of a pattern for a catgut ligature will be illustrated later. The fundamental law involved is expressed by the formula  $n\lambda = d \sin \theta$ —where  $n$  is a whole number,  $\lambda$  is the known X ray wave length (for this work ordinarily the  $\lambda$  ray of copper,  $1.54$  Angstrom units),  $d$  is the spacing of a set of parallel planes which build up the material, and  $2\theta$  is the experimentally measured angle of a diffraction interference corresponding to the given set of parallel planes.

The experimental technique for X ray diffraction analysis of ligatures is comparatively simple as illustrated in Figure 1. An actual apparatus is photographed in Figure 2. A monochromatic beam of X rays defined by small pinholes (about  $0.25$  inches in diameter) is passed through a ligature specimen perpendicular to the fiber axis. A photographic plate is adjusted at a fixed distance behind the specimen, usually  $5$  centimeters. After development of the film the characteristic pattern appears and in accordance with straight forward principles is measured and interpreted in terms of ultimate constitution and structure so that a model can be constructed.

Significant results have already been obtained from the use of this, one of the newest of research tools.

It has been demonstrated that the raw material received by the catgut manufacturer

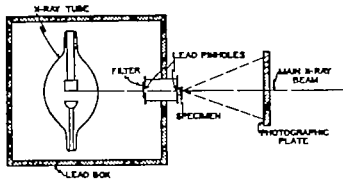


Fig. 1. Diagram of diffraction apparatus.

is extremely variable in structure and thus the technique provides a possible basis for selection of raw material.

2. Catgut structures that go hand in hand with high tensile strength and definite absorption characteristics are easily differentiated from other structures that give low strength and a different absorption curve.

3. It has been demonstrated that it is possible by suitable techniques to alter the structure of catgut. Thus it is possible to go from a less preferred to a more preferred orientation or vice versa.

4. Catgut processing by the manufacturer has a tendency always to change the structural picture usually to a less preferred arrangement of units.

5. A more exact knowledge of the mechanism of chromicizing is an outgrowth of the work.

#### THE SIGNIFICANCE OF A DIFFRACTION PATTERN

Before attempting to interpret the X ray diffraction pattern which is characteristic of a protein fiber such as a catgut ligature, it will be well to select as an example another well known natural substance cellulose the structure of which has been worked out with amazing completeness from X ray data. Figure 3 reproduces the pattern from ramie fibers, one of the varieties of cellulose made by the same technique as already outlined which is utilized for the suture studies. Without examining in detail all the steps in the analysis of the pattern we may outline the definite facts of ultimate structure which are discovered and universally accepted at the present time.

a. In the first place these ramie fibers are



very definitely crystalline or at least contain primarily a crystalline constituent known to be pure cellulose, otherwise there would have been possible no such beautifully symmetrical and sharp a pattern indicative of diffraction of X rays by a three-dimensional grating constituted from molecules marshalled in a lattice work.

b. The pattern definitely proves that the ramie fiber is not a single crystal but is built up from a great number of very small crystal units called crystallites or colloidal micelles which, however, are all arranged in space so that a common direction in them is parallel to the axis of the fiber. In other words this is a case of a high degree of *preferred orientation* or *fibering*. Just to show what happens to the X ray pattern when we have a specimen composed of these same little cellulose crystallites arranged at *random* instead of being all oriented in one direction, we may compare Figure 4 for cellophane with Figure 3 for ramie. Cellophane is a brush heap arrangement of cellulose crystallites; ramie is a sort of chimney built from perfectly arranged bricks. Cotton represents an intermediate state of preferred orientation of these tiny cellulose units as a casual glance at Figure 5 will at once show. These examples illustrate how the X ray patterns can differentiate between orientation of the same crystal units.

c. Careful comparison of the greatly different patterns for ramie, cellophane, and cotton will reveal however certain fundamental identities which prove that all these materials are cellulose. The diameters of the rings upon which the sharp spots in the ramie pattern lie are the same as the ring diameters in the cellophane and cotton patterns. Irrespective of the orientation of the various little crystallites which in a sense are like the grains of sand in a rod of cement concrete, the pattern enables us to tell how each grain is built up from still smaller units, namely molecules and atoms. The pattern tells us, for example, that the very smallest unit of volume which is still cellulose, in other words the real architectural building unit, is a parallelepiped with edge lengths of about 7 by 8 by 10 ten-millionths of a millimeter. This unit cell contains 4 dehydrated glucose  $C_6H_{10}O_5$  groups arranged in

a perfectly definite way; the X ray data tell us exactly where each carbon and oxygen atom is in space. Of course the larger crystallite is built up from the multiplication of this unit cell in all directions. Furthermore we find that a large number of these  $C_6H_{10}O_5$  groups are bound together with oxygen atoms serving as bridges into long chains. Now the crystallite or micelle is simply a bundle of these long chains. The length of the micelle which we may also measure from the X ray pattern is determined by the chain lengths and is about 50 times as long as the side of the little unit cell (about 10 Angstrom units) and the cross section of the micelle is determined by how many chains are in a bundle, and is usually about 50 Angstrom units. So we have the single ramie or cellulose fiber built up from long rod-like crystallites which are about ten times as long as they are thick, these in turn are built up from bundles of long chain molecules; these in turn from a unit crystal cell far smaller than these molecular lengths simply because there is a definite periodicity along the chains; the cell is built up from dehydrated glucose groups, which finally are constituted of carbon, hydrogen and oxygen atoms.

It is needless to point out how extremely valuable this fundamental information concerning the building plan of cellulose has been. The practical properties of materials depend absolutely upon these facts. Suffice it to say that the improvement in the tensile strength of commercial rayon in recent years has been the result of X ray diffraction research. What a given manufacturing process does to a material is immediately indicated by the pattern serving as a super microscope.

#### DIFFRACTION PATTERNS FOR CATGUT LIGATURES

Upon the basis of the foregoing discussion of a typical diffraction pattern which has been extensively studied and fully interpreted it is possible to approach intelligently the interpretation of patterns for ligatures which have not been subjected to any appreciable amount of study. An average diffraction pattern for a commercial catgut suture is reproduced in

Figure 6 and a graphical representation which may be somewhat more easily described in Figure 7. The principal features of this pattern proceeding from the center out are as follows:

a. In the center of the pattern appears the trace of the undiffracted main X ray beam from which point of course the angles  $2\theta$  are measured.

b. A general fogging of the film near the central spot at small angles due to scattering of the rays by truly amorphous material present in the specimen. The intensity is a measure of the amount of amorphous matter as compared with the more definitely crystal line constituents.

c. Two inner arcs lying equatorially on the same circle. This diffraction ring corresponds to a spacing between crystal planes of 11.9 Angstrom units. The great significance of the lengths or sharpness of these arcs will appear in a later paragraph.

d. A broad halo evidently due to a part of the collagen in the ligature which is essentially amorphous or at least much less well organized than the crystalline portion responsible for the sharp interference maxima. The spacing corresponding to this halo is about 4.3 Angstrom units and is evidently quite common for proteins where arrangement on equidistant planes is quite imperfect. Even for this constituent there is a tendency toward preferred orientation or fibering as indicated by the marked bulging of the halo on the equator of the diffraction pattern. In some cases this broad halo is observed to split into two sharper rings.

e. An outer sharp ring usually appearing as two arcs at the poles is an indication of a fiber crystalline constituent and a spacing of 2.8 Angstrom units.

f. In certain cases in which the ligature has been subjected to an unusual degree of tension there appear on the pattern between the inner sharp arcs and the broad halo four sharp spots or arcs lying on the same ring. As will be demonstrated later the appearance of these spots which are not present for the usual catgut specimens has a profound significance in terms of properties and performance of the suture.

#### POSSIBLE VARIATION IN DIFFRACTION PATTERNS FOR DIFFERENT SUTURE SPECIMENS

With the average diagram for a catgut ligature thus described it is possible now to enumerate the variations in the patterns which have been observed in comparative studies of different specimens and to understand the general significance of these variations.

a. The amorphous scattering or fogging near the undiffracted beam which indicates truly amorphous matter may vary from practically zero intensity to a very marked blackening of the film, showing an almost continuous variation between specimens containing little or no amorphous matter to those which are almost completely broken down, for example, by heating or by digestive processes.

b. The innermost sharp ring of all features of the pattern is most sensitive to variations in specimens which appear to be very similar. The arcs which appear ordinarily on the equator of this inner ring may be so long actually as to form a continuous ring. In this case the crystal units responsible for this interference would be distributed at random in much the same way as cellulose crystallites are arranged in brush heap fashion in cellophane. On the opposite extreme these arcs may actually be so sharp and short that they appear simply as spots lying on the equator of the pattern. In this case the crystal units must be oriented in a nearly perfect preferred direction parallel to the axis of the fiber.

Between the two extremes described every possible arc length might easily be observed in different specimens. It is evident therefore, that the length of these arcs is very definitely a measure of the degree of the preferred orientation of the crystalline particles or colloidal micelles which build up the protein collagen fibril. Different ligature specimens can be compared therefore by relative measurements of arc lengths. This comparison may be made strictly quantitative by a new method worked out by Clark and Sisson. A microdensitometer with rotating stage is employed. The film is adjusted so that it may be rotated with this inner circle in focus and successive readings can be made of the actual density of the photographic emulsion which is plotted as a

function of an angle. A curve can thus be drawn whose width is a quantitative measure of the length of the arc. This curve may then be treated mathematically to give definite numerical values, expressing the perfection of orientation of the micelles. These numerical values are highly significant in that they run parallel with measured physical properties such as tensile strength. Other things being equal the shorter and sharper these arcs, indicating high degree of preferred orientation the greater the tensile strength of the fibril. This is true not only of cellulose but also of these protein collagen fibers, silk, keratin etc. The fact that it is possible with any given suture specimen to change these arc lengths by suitable chemical and mechanical methods has given to this X-ray research method an even greater practical significance.

c. Running somewhat parallel with the inner arcs the protein halo may vary from a continuous band of uniform widths representing random distribution to a very high degree of preferred orientation even for this imperfectly organized material. In this case the equator of the band becomes very broad and many times appearing as marked bulges on the band while the polar parts of the band become narrow and quite faint.

d. The lengths of the arcs on the outer sharp ring appearing at the poles may also vary from a continuous circle to short lengths, indicating preferred orientation.

e. It is significant that variations in the widths of the two principal sharp rings and the halo may also be observed as well as variations in lengths. The widths of the interferences are dependent upon the size of the crystalline particles or micelles the broader these maxima the smaller both in length and cross section are these colloidal particles. If we assume for a moment that collagen is built up somehow from long chains similar to those of cellulose then it follows that any rupturing of these chains, or breaking down into shorter molecules and smaller colloidal particles would show by an increase in width of the lines or spots appearing on the pattern.

f. A very significant variation in patterns is the appearance or non-appearance of an additional diffraction ring which appears

simply as four sharp arcs between the inner ring of small diameter which is always present and the broad halo. The appearance of these new spots is always associated with the shortest and sharpest arc lengths on the other rings—in other words, with the highest degree of fiberling. In general the appearance of these new interferences then would indicate sutures of unusual quality, especially as regards tensile strength. They appear only very occasionally in ordinary commercial specimens of raw catgut or of finished sutures, but it is significant that they can be made to appear by certain developed techniques. This process will be considered in a later section of the paper. Having now considered the possible variations in a diffraction pattern which we might observe by a comparison of various specimens we may now proceed to examine the significance of this diffraction pattern in terms of how a protein fibril is built in the ultimate sense and how actual specimens, all built from the same fundamental units of familiar chemical composition may yet vary markedly in architectural and in physical and even chemical, behavior.

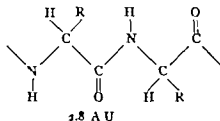
#### THE RELATION OF SUTURE DIFFRACTION PATTERNS TO X RAY RESULTS ON COLLAGEN AND GELATIN

The catgut ligature pattern is in general agreement with that of collagen and gelatin which have been known for several years.

Thus for a dried block of gelatin there are observed two sharp rings corresponding to crystal dimensions of 11.9 and 2.8 Angstrom units, and a broad halo for an amorphous part with the spacing 4.3 Angstrom units, exactly as found for fibrous catgut and collagen. Furthermore gelatin may be stretched as much as 300 per cent yielding a fiber pattern with the new additional sharp spots between the innermost ring and the broad halo which is practically indistinguishable from that of catgut or fibrous collagen. An additional spacing the identity period along the fiber axis, may now be determined from the layer line diagram. This is 9.5 Angstrom units. Hence two of the three dimensions of the unit crystal cell containing the crystalline protein are 9.5 and 11.3 Angstrom units.

## FUNDAMENTAL CONCLUSIONS ON PROTEIN STRUCTURE

Natural silk fibers formed from the protein fibroin were the first studied by X ray methods to give a clue as to the problem of the structure of the protein molecule as a whole. Natural silk does not give such a complete fiber diagram as that of cellulose but Meyer and Mark applied to it principles learned from the latter and suggested that the fibroin crystallites also were no other than bundles of long molecular chains. Just as the long chains in cellulose consist of a repeating unit of the dehydrated glucose residue so the protein chain is built up from units mainly joined through peptide linkages. The remarkable studies on stretched wool and hair by Astbury and by one of the writers give further definite confirmation to this conception. The result is a long polypeptide chain with the length of the repeating unit usually 3.5 Angstrom units, although this varies somewhat with the protein and is probably 2.8 for catgut. This is illustrated diagrammatically as follows:



In this diagram 'R' represents any side group attached to the main backbone chain. These groups differ from one protein to another and of course, serve to distinguish the behavior particularly as regard swelling in water of various types of proteins. The diffraction pattern for catgut ligatures or collagen fibers then relates itself directly to the more definitely crystalline patterns for silk and stretched keratin. Poor as the photographs are when judged by standards of ordinary crystalline analysis the fact that any pattern at all is obtained suggests that there must be a crystalline part of the fiber substance. The sequence of amino acid residues cannot be extremely irregular. Only a fraction of the fiber substance is in such a definitely crystalline state as to contribute to the

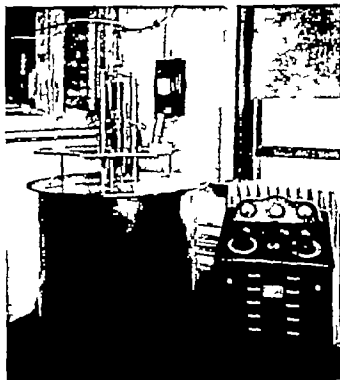


Fig. 2 Photograph of diffraction apparatus.

photograph proper, and it is an interesting and important point as to how far the X ray indications apply to the fibril as a whole. The most reasonable point of view as pointed out by Astbury is that there is no such thing as a pure chemical protein in the ordinary chemical sense but that the X ray photograph presents an ideal toward which the structure approximates.

The setting of a gelatin sol to a gelatin jelly is associated with a change in the X ray diffraction patterns as has been observed frequently in this work. The diagram for the sol indicates an amorphous structure while the jelly has well defined rings characteristic of crystal structure. Jelly formation is therefore due to development of some degree of organization. Knowledge of actual structural constitution of a catgut fiber is aided very materially by studies of swelling. These observations which will be reported elsewhere in detail together with the characteristic X ray diffraction pattern, suggest that the catgut collagen fibril is composed of a bundle of the protein molecules arranged with backbones parallel to the long axis of the fibril and held together by co-ordinate linkages between backbones of adjacent molecules. Thus col-



Fig. 3 Diffraction pattern for ramie (cellulose) fiber

lagen differs from gelatin only in this very definite arrangement of the long chains. Strong cohesive forces of these molecules in such definite arrangement serve to reduce the swelling of collagen in water to a very much lower value than that of equally concentrated jelly under the same essential conditions. It follows from all the evidence that the hydration or swelling of proteins depends upon chemical constitution of chemical molecules and on molecular organization the latter being the significant factor which differentiates catgut from gelatin. This so called molecular organization increases step by step in the following list of protein substances: gelatin, muscle, catgut, wool, keratin, horse hair, keratin and fibrous silk gut. It follows then that the swelling and hydration as well as other physical properties, such as tensile strength, for the same protein will be conditioned by the degree of fibering as for example in catgut ligatures. This can be controlled. The practical behavior also should be subject to control. Experimental results on this point are presented in a later section.

We must conclude from all the data available therefore, that the catgut ligature is built according to an architectural plan exactly as cellulose is built even though from vastly different chemical substances. Crystallites, or micelles, are built up from long chains held together in bundles. These bundles tend to be oriented in a common direction parallel to the axis of the fibril in a greater or less degree of perfection. The micelles



Fig. 4 Pattern for cellophane.

tend to hold each other in position by virtue of active chemical groups on the surfaces of the particles which are extensions from the backbones and even the fibrils in a fiber exercise certain attractive forces upon each other which materially affect the ability to absorb water or other reagents. These micelles or bundles thus may be pictured as somewhat elastic or worm like rods because of the nature of the protein chain. The X ray spacings correspond to a definite direction along the chains or to the cross section of a bundle of chains.

It follows then that the swelling and hydration as well as other physical properties for the same protein will be conditioned by the degree of fibering. If for example, in catgut ligatures this can be controlled the practical behavior also should be subject to control.

The foregoing discussion of protein structure while still imperfectly understood in detail has been derived from repeated X ray determinations. Clark, Bucher and Lorenz have used the X ray diffraction method in the study of normal and pathological human tissues, including stretched and unstretched tendons and muscles. Extension of these specimens always results in a parallel alignment of long protein molecules and typical fiber diffraction pattern. This has been demonstrated even on living frog muscles excited to tetanus contraction. Cancerous tissues show patterns which differ from those for normal tissue thus proving a changed molecular constitution and form. These experiences have thus permitted a logical and intensive investigation upon the whole



Fig. 5 Pattern for cotton fiber

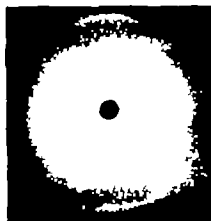


Fig. 6 Pattern for average catgut fiber

problem of surgical ligatures. The present paper is limited to the usual type of collagen "catgut" ligatures starting from the raw material derived from the intestinal walls of sheep.

#### A COMPARISON OF RAW CATGUT AND FINISHED LIGATURES FROM VARIOUS SOURCES

All raw catgut and finished ligature specimens yield diffraction patterns characteristic of protein collagen with unit cell dimensions already noted. Specimens are differentiated from each other, however, with great sensitivity by the degree of preferred orientation of the micelles with respect to the long axis of the fiber. This is measured especially well by the length of innermost equatorial arcs which correspond to the 119 Angstrom units dimension. Figure 8 reproduces patterns of raw catgut and Fig. 9 of commercially competing finished ligatures to illustrate the wide variation possible.

The following general conclusions may be derived from a large number of X-ray studies:

a. Raw catgut has a higher degree of preferred orientation than any specimen following further processing provided that tension and stretching are not applied during processing. Elevated temperatures and swelling treatments invariably disarrange a parallel micellar arrangement to a greater or less extent.

b. Commercial catgut samples are distinguished chiefly by the lengths of arcs on the inner sharp diffraction ring. A rating on

performance as to tensile strength uniformity, and absorption time in the tissues can be made from patterns. In general the shorter and sharper the arcs on the inner interference ring and the narrower the corrected microdensitometer curve the stronger the ligature, other things being equal. X-ray patterns show remarkable differences between ligatures from different manufacturers and in some cases in different lots from the same manufacturer while other commercial ligatures are remarkably consistent. Variations in raw material and the slightest differences in any chemical treatment, tension or temperature all change the structure and the controlling X-ray pattern.

#### THE EFFECT OF TENSION ON CATGUT

If the structure pictured for catgut is true and it explains all known facts of behavior, it should be possible by suitable tension on the

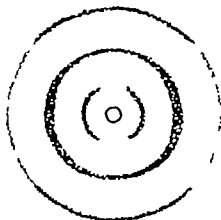


Fig. 7 Drawing of pattern for catgut.

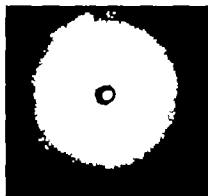


Fig. 8 Pattern showing no fibering or preferred orientation in catgut suture

catgut fiber rendered plastic by swelling agents to pull the micelles into still more perfect alignment. The X ray diffraction pattern proves this to be the case for the pattern not only shows sharper fiber intensity maxima but four new intensity maxima symmetrically arranged between the inner crystal ring and the amorphous halo.

This diagram indicates a degree of symmetry superior to that observed for most ordinary commercial catguts: there is distinctly an axis of orientation parallel to the direction of tension and stretching and the structure approaches that of a well oriented crystalline substance. The new intensity points enable very accurate calculation of the identity period along the fiber axis, namely about 9.5 Angstrom units. In other words, some combination of atoms along the complex polypeptide chains repeats itself. Another dimension or cross section of the unit crystal cell is the 11.9 Angstrom units deduced from the inner spots. Without assumptions the third dimension cannot be directly deduced. Such a pattern however is obtained only under these conditions of swelling and tension. One or two samples of raw catgut have shown faint evidence of the four points which appear only for excellent orientation evidently in instances in which unusual tension in drying has been employed.

Further processing into final sterile ligatures always has a tendency to remove this evidence and consequently to leave less perfect orientation.

#### THE RELATIONSHIP BETWEEN STRUCTURE AND TENSILE STRENGTH

Experiments on rayon indicated that when the cellulose filament was regenerated from solution under tension the micelles were more perfectly aligned than in ordinary varieties as indicated by a far more highly fibered diffraction pattern and the tensile strength was considerably enhanced. The surface forces of the micelles were able to bind the micelles into a strong unit as compared with a brush-heap micellar arrangement. Similarly cotton which has been swollen and stretched in the solid phase becomes stronger by 50 per cent or more. Some typical data as to the effect of good orientation on tensile strength are as follows:

Material	Lb Kg./mm <sup>2</sup>
Cast iron	30
Steel	170
Copper wire	40
Aluminaum	10
Lead	3
Wood in fiber direction	8-5
Silk	35
Cotton	25
Ordinary viscose rayon	15
Well oriented viscose rayon	80
Ordinary acetate silk	5
Well oriented acetate silk	100
Ordinary rubber	5.30
Rubber (well oriented)	80

Bergmann and Jacobs have shown for a band of gelatin the following:

Gelatin unstretched	4.4 kg./mm <sup>2</sup>
Gelatin stretched 300 per cent	9.3

For tendons or fibrous collagen the following data have been obtained by Vance:

Tendon (rubine)	11.0 kg./mm <sup>2</sup>
Same heated and shrunk at 80° (X-ray fiber pattern disappears)	3.0
Stretched again to original length	1.6

The shrunk and stretched tendons are thus exactly analogous to rubber. That the chains on the stretched tendons lie in the fiber direction can also be shown by freezing. There is a marked cleavage in the fiber axis while the shrunk tissue breaks into clumps. By heat treatment therefore the principal valence chains change their form and become rolled up and the X ray pattern disappears. The same effect can be accomplished on catgut by swelling media.

The X ray pattern of catgut ligatures should therefore be an indication of tensile strength—the more strongly fibered or perfectly oriented, the stronger in general. Hence, the process of stretching catgut, leading to the appearance of the four new interference points (the most sensitive and accurate criterion) should be accompanied by changed mechanical properties and enhanced strength.

Tensile strength is obviously a function of gauge or diameter, strength increasing with gauge. If it were possible to decrease the gauge of any given strand of gut without causing a change in tensile strength in effect the ratio of strength to gauge would be increased. With this in mind a series of experiments were carried out to determine if improvement in tensile strength could be effected by drying catgut while the length is maintained constant which in effect introduces tension or even with the maximum tension possible. To this end a number of strands of raw catgut representative of a production lot were selected and thoroughly wetted. One half of each original strand was then allowed to dry under room conditions except that tension was applied.

Subsequent measurements proved that on an average the application of tension caused a reduction in gauge or diameter over that of gut dried without tension. A direct comparison of strength data as obtained indicates that strength is slightly improved by tension drying. However a comparison after correction for variations in gauge points to a marked increase in strength per unit gauge for gut dried under tension. The tension dried gut showed the more preferred micellar orientation.

In continuing the study of the effect of drying under tension a series of experiments were made on plain non-boilable catgut. This product may be considered as raw catgut which has been subjected to an elevated temperature for a period of hours. This process removed all moisture from the gut. Experiments were made directly after removal of the gut from a 98 per cent alcoholic solution in which it had been stored for periods ranging from 6 months to 4 years. In all cases



Fig. 9. Pattern showing opposite extreme of excellent preferred orientation.

swelling was perceptible and the gut stretchable. Other experiments were also made on gut which had been allowed to swell in water or water solutions of various swelling agents.

Here again as with raw catgut the application of tension to gut while swollen and its maintenance under that condition while drying resulted in improved tensile strength.

#### THE RELATION BETWEEN STRUCTURE AND ABSORPTION

Closely related are the relationships between structure and chemical attack. When rubber is strongly stretched or racked not only is the tensile strength increased but also the swelling properties changed. Such racked threads can remain for long periods in the usual rubber solvents such as chloroform without being attacked. Strongly oriented cellulose fibers also resist swelling and are dyed with difficulty. So in catgut ligatures the time of digestion by tissue fluids or by standard tryptic enzymes should be related to structure especially as regards time required for penetration and swelling of the fiber. This is proved by the fact that ligatures near knots remain after other portions are digested. X ray patterns show that at knots an improved preferred orientation is produced by the tension so exerted.

#### SUMMARY OF COMPARISONS OF LIGATURES FROM X RAY DATA

1. Raw catgut has a higher degree of preferred orientation than any specimen follow



ing further processing. Elevated temperatures or swelling treatments invariably disarrange a parallel micellar arrangement to a greater or less extent.

2 Commercial samples are chiefly distinguished by the lengths of arcs on the inner sharp diffraction ring. A rating on per formance as to tensile strength uniformity and absorption time in the tissues undoubtedly can be made from the patterns and a measurement of these arc lengths—the shorter and sharper the stronger the ligature. Other things being equal, X ray patterns show remarkable differences between ligatures from different manufacturers, and in two or three cases from different lots from the same manufacturer while other commercial ligatures are remarkably consistent. Variations in raw material and slightest differences in any chemical treatment, tension or temperature all change the structure and the controlling X ray pattern.

3 Carefully regulated swelling and tension produce a characteristic effect in the X ray patterns which has been described. Any ligature which shows clearly the four point diagram between the inner ring and the amorphous halo may be said to have a high degree of preferred orientation and probably superior tensile strength and definite absorption characteristics. These orientation interference points appear rather suddenly and only when tension has been applied. Normal gelatin tendons, or collagen specimens do not show them. As orientation improves the innermost and outermost arcs shorten progressively to a point where the 4 point layer line diagram appears. The importance and significance of this phenomenon in rating ligatures cannot be overestimated.

4 Interesting changes are observed when ligatures are planted in animals and allowed to undergo digestion by body fluids. Knots present greatest resistance because as proved by X ray analysis, preferred orientation is enhanced by the tension of the knot. For straight lengths subjected to varying digestive action various types of diffraction patterns suggest that the process is something as follows:

a The Amorphous portion consisting

of shorter molecules statistically disorganized is first attacked. The amorphous halo decreases in intensity in comparison with the sharp crystalline rings and becomes somewhat sharper and definite as the "sorting" process proceeds. The crystalline portion and the parallel orientation is unaffected.

b As the cementing amorphous material disappears the crystal micelles become disarranged and the arcs increase in length progressively until practically continuous rings indicative of random orientation appear.

c In the final stages the sharp crystalline rings become less definite and amorphous scattering or fogging near the center show the disintegration process of both crystal micelles and disorganized matter initially present.

5 The diffraction pattern of chromicized gut is very similar to the untreated material. In general a somewhat better preferred orientation of crystal micelles than in ordinary ligatures is observed. The chromicizing treatment evidently tends to hold the micelles in position and to offset swelling or temperature effects.

6 New crystalline compounds or evidences of inorganic chromium compounds have never been observed on diffraction patterns. In one or two cases of treatment of gut with very concentrated chromicizing solutions a few single spots due to isolated single crystal grains have appeared, but these cannot be identified. Crystalline layers of dichromate or of chromic oxide, the reduction product, have not been found. The evidence therefore is that a non-crystalline addition complex is formed the structural backbone of which is essentially the same as the protein. Chromium is unquestionably present since it may be found by microchemical tests. Some ligatures were heated at temperatures just below charring for as long as 48 hours, which would be sufficient for dehydration of any colloidal hydroxides. Even after this treatment no evidence of crystalline oxides is found.

7 The vulcanization of rubber seems to be quite analogous to the chromicizing of catgut. No evidence of crystalline sulphur is ever found up to a certain limit and the appearance of a fiber pattern on stretching is identical.

tical with that of unvulcanized rubber except for one change the crystal interferences are actually narrower indicating a larger colloidal particle size as though the sulphur had bridged initial units together. Exactly this same observation is made for chromicized gut. The arcs and spots on the crystal rings are measurably narrower so that chromium in some form bridges protein particles together into larger units. This X ray observation is also consistent with greater resistance to swelling and absorption.

## BIBLIOGRAPHY

- BERGMANN M. and JACOB B. *Kolloid-Ztschr.* 1929, xlix, 46.  
 CLARK, G. L., BOCHER, C. S. and LORENZ O. *Radiology* 1931 xvii, 482.  
 CLARK, G. L., and LAWSON C. *Applied X rays*. 1st ed. p. 194. New York. McGraw Hill Book Company 1927.  
 CLARK, G. L., and SIMON W. A. *Industrial and Engineering Chemistry, Analytical Edition*, 1933 v. 296.  
 GURLT, E. *Geschichte der Chirurgie und ihrer Ausübung* 3 vols. Berlin, 1808.  
 GREYENBROEK, W. *Historisch-kritische Darstellung der Lehre von der Unterbindung der Blutgefäße*. *Deutsche Ztschr. f. Chir.* 1882 xvi, 111-148, 285-329.  
 HERMANN, K., GERNIGROSS, O. and ARITZ W. *Ztschr. f. phys. Chemie*, 1930, x, 371.  
 HERZOG R. O. *Helvetica Chimica Acta* 1928, xi, 529.  
*Berichte den deutschen Chemischen Gesellschaft*, 1925 lviii, 2225.  
 KATZ, J. R., and GERNIGROSS, O. *Naturwissenschaften*, 1925, xiii, 900. *Kolloid Ztschr.* 1926, xxxix, 181.  
 LISTER, J. Observations on ligatures of arteries on the antiseptic system. *Lancet*, 1869, i, 451.  
 MEYER, K., and MARK. *Biochem. Ztschr.* 1929, ccxiv, 253.  
 PARÉ, A. *Oeuvres complètes*, par J. F. Malgaigne, 3 vols. Paris, 1840.  
 PENNYCK P. S. *Elect. Repert. & Anal. Rev.* vol. vi pp. 389-390. Philadelphia, 1816.  
 PORTA, L. *Delle alterazioni patologiche delle arterie per la legatura e la torsione, esperienze ed osservazioni*, p. 40. Milano.  
 TRILLAT J. J. *J. de chim. phys.*, 1932 xxx, 1.

Acknowledgment must be made to the Curity Suture Laboratories who provided the funds for this work in such a fundamentally important field. Research in the realm of protein structure is only beginning. But even in this beginning the medical scientist cannot but feel a sense of added indebtedness to X rays, so indispensable in diagnosis and therapy and now presented in a third great field of application. With X rays one can see far beyond the microscope down to the ultimate arrangement of atoms and molecules even in living tissues and find there the real secret of constitution and practical behavior of material things.

## THE PREVENTION OF PERSISTENT AND RECURRENT HYPERTHYROIDISM

BASED ON A STUDY OF SEVEN HUNDRED SIXTY NINE CASES OF EXOPHTHALMIC GOITER

ARNOLD S. JACKSON, M.D., F.A.C.S., MADISON, WISCONSIN  
Jackson Clinic

THE literature contains some twenty articles relating to recurrent or persistent hyperthyroidism but none pertaining to the particular phase to be discussed. Recurrence in toxic adenomata is of such rarity as scarcely to merit discussion. There have been several excellent dissertations on recurrent exophthalmic goiter the most important being those by Drs. Clute Lahey, Pemberton and Thompson. The paper by Thompson and his associates A. E. Morris and P. K. Thompson is most instructive and comprehensive and should be read by anyone interested in the subject of hyperthyroidism. In this short treatise it is impossible to discuss the opinions of these authors none of whom was especially concerned with the problem of prevention. Lahey, Clute and Thompson were really dealing with persistent rather than recurrent hyperthyroidism since in their analyses the latter condition was rarely observed.

Lahey and Clute reported 34 cases of primary hyperthyroidism in which the patients returned for secondary operation. In 19 the metabolic rate never returned to normal after the first operation consequently they were cases of persistent rather than recurrent hyperthyroidism. Of the latter group they reported only 5 cases. Likewise Thompson et al. in reviewing the cases operated on at the Massachusetts General Hospital during the years 1923 to 1928 found that while 37 of 190 cases or 19.5 per cent showed definite clinical evidence of postoperative thyrotoxicosis, in only two instances was there a true recurrence.

On the other hand Pemberton recently estimated the incidence of postoperative thyrotoxicosis following subtotal thyroidectomy for exophthalmic goiter at the Mayo Clinic as certainly not more than 5 per cent. Frazier and Mosser followed up a series of 100 cases of exophthalmic goiter in 1928 and found that

1 per cent had persistent hyperthyroidism and 4 per cent had recurrent hyperthyroidism. In 1920 Mason found that a second operation was necessary in 12 per cent of a series of 43 cases of exophthalmic goiter. Undoubtedly the advent of iodine would considerably alter these figures.

A review of the literature as shown by Thompson indicates that the incidence of thyrotoxicosis after subtotal thyroidectomy for exophthalmic goiter ranges from 0.25 to 25 per cent many of the estimates falling in the vicinity of from 5 to 7 per cent. The value of these statistics depends upon the accuracy of the follow up, the number of personal examinations, and the interval elapsing since the operation—points emphasized by Pemberton.

Patients failing to reply to a questionnaire or reported lost may have gone elsewhere for a second operation. Surgeons may hesitate to discuss unsuccessful results but since the technique of thyroidectomy has become standardized there is no reason why this subject should not be frankly considered. Any experienced thyroid surgeon knows that complications occur in spite of the greatest care and attention to details. Regardless of a correct diagnosis, a well planned pre-operative and postoperative regimen and a technically perfect thyroidectomy hyperthyroidism may return just as cancer does 1, 5 or even 20 years later. Occasionally a second or third operation may not be successful. Once I performed the fourth thyroidectomy on a patient who had previously been operated on by two of our leading thyroid surgeons.

Fortunately however these cases are the exception and considering the fact that 5,000 or more thyroidectomies are performed each year for exophthalmic goiter the number of recurrences is small certainly not in excess of 10 per cent although this figure might be

TABLE I.—AVERAGES OF ALL CASES OF PERSISTENT EXOPHTHALMIC GOITER OBSERVED AT JACKSON CLINIC 1922-1932

No cases	19
Average age	35
Sex	M 7 F 12
Duration symptoms	57 months
Tonilla	8 septic 6 no record
Original weight loss	24 pounds
B.M.R. on admission	+48.5 per cent
B.M.R. on return	+51.3 per cent
B.M.R. on discharge	+8.1 per cent
Weight gain	21 pounds
B.M.R., basal metabolic rate	

TABLE II.—PERSISTENT CASES OF EXOPHTHALMIC GOITER CURED WITHOUT OPERATION

No cases	3
Average age	37 <sup>2</sup> / <sub>3</sub>
Sex	M 1 F 2
Duration symptoms	6.5 months
Tonilla	septic, 1
Weight loss	19 pounds
B.M.R. on admission	+45 per cent
B.M.R. on readmission	+53.6 per cent on iodine
B.M.R. on discharge	+13.6 per cent no iodine
Weight gain	13.3 pounds

exceeded if all cases of persistent hyperthyroidism were included

Before continuing I shall define the terms "recurrent" and "persistent" hyperthyroidism. The recurrent case is any case of exophthalmic goiter in which iodine is not given but the patient shows a normal metabolic rate with complete abatement of symptoms for 3 months or more following subtotal thyroidectomy and then develops a recurrence with signs and symptoms of hyperthyroidism together with an increased basal metabolic rate. Persistent hyperthyroidism means a continuation of the clinical signs and symptoms of exophthalmic goiter together with an increased metabolic rate after the withdrawal of iodine for a period of 6 months or longer following subtotal thyroidectomy—the condition being the result of the removal of an insufficient amount of thyroid gland.

I reiterate that hyperthyroidism recurring after thyroidectomy for toxic adenoma is so rare as to obviate consideration, nor are we concerned with that type of case in which symptoms of a permanently damaged cardiovascular system persist after a too long delayed thyroidectomy. Every surgeon doing thyroid surgery is familiar with the neglected case of hyperthyroidism that improves following thyroidectomy only to die a cardiac death a few years later.

At the Jackson Clinic between 1922 and 1932, 722 operations including ligations, lobectomies, and thyroidectomies have been performed on 769 patients with exophthalmic goiter. During this period of 10 years a total of 22 patients were operated upon for persistence of the disease following thyroidectomy, 5 of these had had the primary opera-

tion elsewhere and 17 underwent their first operation at the Clinic. Of the 22 patients with persistent hyperthyroidism, 3 have been restored to normal health without surgery by methods to be discussed. With the exception of one case now under observation, these patients have remained well 6 months or longer without iodine and may be considered as well. That does not mean that at any time in the future the disease may not recur a possibility in every case of exophthalmic goiter.

It is contrary to the experience of Lahey and Clute who state that in no case of persistent or recurrent hyperthyroidism in their experience has the use of iodine resulted in a cure. I have been interested in this subject for several years and have reported two cases of this type restored to normal health. In the majority of patients however, it is necessary to remove more thyroid tissue.

In 4 instances a third thyroidectomy was required before the patient was relieved of hyperthyroidism, 2 of these were Clinic cases.

There were 36 cases of recurrent hyperthyroidism, in 25 of which the patients had undergone thyroid operations by other surgeons. Of these 16 probably had only a lobectomy at their first operation since this was then the operation of choice. Two patients have refused surgery and their symptoms are partially controlled by iodine but a prolonged low grade hyperthyroidism is beginning to effect cardiac damage.

Just as we must start the prevention of simple goiter by administering iodine during pregnancy, so must we begin at the earliest opportunity to prevent the development of persistent and recurrent hyperthyroidism. The surgeon may be blamed in many instances

TABLE III—RECURRENT EXOPHTHALMIC GOITER PROBABLY HAD LOBECTOMY ELSE WHERE

No. cases	14
Average age	40
Sex	M, 5 F 9
Duration symptoms	10.2 months
Tonsils	Septic, 3 no record, 5, 12
Weight loss	23.2 pounds
B.M.R. on admission	+24.9 per cent
B.M.R. on discharge	+2.6 per cent
Weight gain	19.8 pounds

TABLE IV—AVERAGES OF ALL CASES OF RECURRENT EXOPHTHALMIC GOITER OBSERVED AT JACKSON CLINIC 1922-1932

No. cases	32
Average age	39
Sex	M, 7 F 25
Duration symptoms	9.3 months
Tonsils	Septic, 14, no record, 18
Weight loss	24.6 pounds
B.M.R. on admission	+30.4 per cent
B.M.R. on discharge	+3.7 per cent
Weight gain	21.9 pounds

for a persistence of hyperthyroidism because of a failure to remove sufficient thyroid tissue yet he cannot always be held responsible. Doing the same operation day after day it is unreasonable to believe that his technique might so vary as to fail to remove enough gland in 1 out of every 10 or 20 cases. More likely the tremendous force that is driving the gland continues to carry on in spite of a thyroidectomy that would usually be adequate. One learns to anticipate trouble in the extremely acute vascular type and in these as much thyroid tissue as possible should be removed without causing hypothyroidism or injuring the parathyroid glands or the recurrent laryngeal nerves. I agree with Pemberton when he says. Today these are far too excessive a price to be paid for the removal of goiter. One case of postoperative myxedema, and that an unusual one in which 2 years following the removal of a non-toxic adenoma it was necessary to reoperate for an exophthalmic goiter has occurred in my experience. Since 1925 no cases of tetany or of nerve injury have resulted. Probably my percentage of persistent hyperthyroidism and recurrence is higher than it should be but, so far as I know every case that has permitted treatment or reoperation is well today.

If postoperative thyrotoxicosis is to be successfully combated, certain facts must be impressed upon the patients from the first day. They must realize that a thyroidectomy is not the same as an appendectomy. Written rules to follow both before and after operation should be given patients because in their nervous, high strung condition most advice goes in one ear and out the other. To restore their health is not sufficient they must be kept well to prevent a recurrence. One must

use tact, of course and not frighten already apprehensive patients. They should be assured that with co-operation health will be restored.

Because of the many probable etiological factors in exophthalmic goiter every patient must be individually considered and advised. In one infections such as tonsillitis and influenza appear to be important in another prolonged mental and physical strain such as the care of a sick relative or occupational stress as experienced by stenographers, telephone operators, etc. Pregnancy and menopause may initiate hyperthyroidism likewise shock, worry iodine deficiency and a nervous constitution. The increased incidence of hyperthyroidism that followed the influenza epidemics of 1918 to 1921 is well remembered. Septic tonsils appear to be such a definite factor in many of my patients that for several years I have advised tonsillectomy 2 or 3 months after thyroidectomy when indicated.

If occupation is a possible etiological factor a change should be advised and a lighter out door form suggested. There should be relief from the burden of too many duties either at home or in the office.

The patient who fails to gain weight following thyroidectomy probably has a persistent hyperthyroidism. The importance of gaining weight within the first 6 weeks following operation must be emphasized. A gain of 10 pounds the first month is the minimum specific instructions should be given regarding a high caloric diet, regular weighing etc. All stimulants and particularly coffee should be permanently dispensed with.

Persistent and recurrent hyperthyroidism is especially apt to occur in young people who have a tendency to overestimate their ability

ties. They should be cautioned against loss of sleep and rest. The relief of part or all school work is advisable.

Iodine therapy is of the utmost importance. Thirty drops of Lugol's solution is given daily when the patient leaves the hospital. This amount is decreased to 5 drops three times a day after 4 weeks and this dosage is continued for 6 months or longer as indicated.

If hyperthyroidism shows a tendency to persist or recur, it may be possible to alleviate the symptoms entirely and effect a cure by the use of iodine, a high caloric diet, rest, and the removal of septic tonsils, provided the patient is seen in sufficient time.

If after several months trial, the thyroid enlargement does not diminish if the metabolism is elevated and the patient loses weight when iodine is withdrawn, then the remaining excessive tissue should be removed. If this is not done the prolonged effect of even a low grade hyperthyroidism will be manifested by cardiac arrhythmia, myocarditis and hypertension.

In conclusion, I wish to discuss briefly the most important single factor, the use of iodine excepted, in the prevention of persistent and recurring hyperthyroidism. By the use of the radio-electrical surgical knife during the past 3 years, I have practically eliminated these problems. Attention has been called to the use of this method by Mock, Bartlett, Tinker, and myself.<sup>1</sup> With the swift cutting radio knife it is possible to remove all but a shell of the diseased thyroid gland, without endangering the laryngeal nerves or the parathyroid glands. It is impossible to perform as complete and thorough an operation with the scalpel, and when occasionally compelled to forsake the radio knife because it is unavailable I feel that I have gone back 5 years in surgery.

When the gland has been completely peeled out as one would an orange it is possible with the high frequency or coagulating current to sear over the entire inner surface coagulating any bleeding points and by producing fibrosis destroy all but the external surface. With such an extensive operation and recovery so

rapid, postoperative myxedema might be expected, but no instance of this has occurred nor is postoperative drainage a factor, since we seldom use a drain.

Experience is required just as with any other new procedure and important vessels such as the superior or inferior thyroid arteries or the lateral veins should not be coagulated. With practice it is possible to perform thyroidectomy far more quickly more thoroughly, with fewer complications and with better end results by this method.

The incidence of persistent and recurrent hyperthyroidism at the Jackson Clinic has been reduced from 55 per cent in 1925-1928 to 1 per cent in 1930-1933 by this method. It is possible that more recurrences will develop in time but I am satisfied that electrosurgery has largely eliminated this most serious indictment of the surgical treatment of exophthalmic goiter.

#### SUMMARY

An analysis is presented of 22 cases of persistent and of 36 cases of recurrent hyperthyroidism based on a study of 769 patients with exophthalmic goiter observed at the Jackson Clinic 1922-1932. During this period there were 722 operations performed on patients with exophthalmic goiter.

Of the 22 patients with persistent hyperthyroidism 17, or 77.27 per cent, had previously undergone a subtotal thyroidectomy at the clinic. Three of the 17 cases were restored to normal health without further surgery. Iodine rest, a high caloric diet, the elimination of worry, strain, and focal infection were important factors.

A second thyroidectomy was performed on 12 of the persistent cases and a third on 2 of them. At present all are well with a normal basal metabolic rate 6 months after withdrawal of iodine. Two cases have refused operation, and while their symptoms are partially controlled by iodine there is evidence of increasing cardiac damage.

Of the 36 cases of recurrent hyperthyroidism, 11 or 30 per cent had previously undergone operation at the Clinic. The primary operation in 16 of the 36 recurrent cases operated upon elsewhere was probably only

<sup>1</sup>Mock, J. Am. M. Ass.; Bartlett, Surg., Gynec. & Obst.; Tinker, Am. Surg.

a lobectomy Twenty three of the 58 cases of persistent and recurrent hyperthyroidism had septic tonsils at the time of thyroidectomy Tonsillectomy is advised within 3 months following thyroidectomy in all cases of exophthalmic goiter with septic tonsils.

The basal metabolic rate of the 22 cases of persistent hyperthyroidism averaged plus 48.5 per cent on admittance and plus 8.1 per cent on final discharge.

The average weight loss was 24 pounds before thyroidectomy The average weight gain was 21.5 pounds on discharge

The basal metabolic rate of the 36 cases of recurrent hyperthyroidism averaged plus 39.4 per cent on admittance. The basal metabolic rate of the 11 cases having their primary thyroidectomy at the Clinic was plus 37 per cent. On readmission the basal metabolic rate averaged plus 48 per cent and on final discharge plus 6 per cent. The average weight loss of the 36 cases previous to the second thyroidectomy was 24.6 pounds and the average weight gain on discharge was 21.9 pounds

Of the 22 cases of persistent hyperthyroidism there were 12 females and 7 males averaging 35 years of age.

Twenty five of the 36 cases of recurrent hyperthyroidism were females and 7 were males averaging 32 years of age.

In the prevention of persistent or recurrent hyperthyroidism, the following factors are stressed

The use of iodine for 6 months or longer following thyroidectomy Special care of the acute fulminating type with the large vascular gland.

Elimination of focal infection, worry strain, and occupational factors.

The importance of weight gain especially in the first 6 weeks.

Permanent abstinence from coffee and other stimulants.

The use of the radio electrosurgical knife has largely eliminated the factors of persistent and recurrent hyperthyroidism. Their incidence has been reduced from 5.5 per cent in 1925-1928 to 1 per cent during 1930-1933 at the Jackson Clinic.

#### REFERENCES

1. CLUTE, H. M. Hyperthyroidism persisting after thyroidectomy: the necessity for postoperative examination in toxic goiters. *Surg. Clin. N. America*, 1926, vi, 691.
2. ELIX, J. E. Prevention of recurrent goiter. *Surg. Clin. N. America*, 1928, viii, 1375.
3. FRAXER, C. H., and MORSE, W. B. End-results from the surgical treatment of hyperthyroidism. *J. Am. M. Ass.* 1928, xi, 657.
4. LARKE, F. H., and CLUTE, H. M. Persistent and recurrent hyperthyroidism. *Ann. Surg.*, 1926, lxxviii, 99.
5. MASON, J. T. Mistakes in one hundred thyroidectomies, with description of a new method of thyroid cauterization in treating exophthalmic goiter. *J. Am. M. Ass.* 1920, lxxv, 60.
6. FARMINGTON, J. D. J. Recurring exophthalmic goiter: its relation to the amount of tissue preserved in operation on the thyroid gland. *J. Am. M. Ass.* 1930, xlii, 1483.
7. THOMPSON, W. O., MORSE, A. E., and THOMPSON, P. K. Thyrotoxicosis following subtotal thyroidectomy for exophthalmic goiter. *Arch. Int. Med.* 1930, xli, 946-972.

RELAXATION OF THE PELVIC JOINTS IN PREGNANCY<sup>1</sup>DANIEL ABRAMSON M.D., SUMNER M. ROBERTS M.D., F.A.C.S. AND PHILIP D. WILSON M.D.  
F.A.C.S. BOSTON*From the Departments of Obstetrics and Orthopedic Surgery of the Harvard Medical School and the Boston Lying-In Hospital*

KNOWLEDGE of the behavior of the pelvic joints in pregnant women is of interest not only in relation to the clinical management of the puerperal state and of its complications, but also because of the light it may shed upon a type of physiological process affecting certain articulations about which little is known. That relaxation of the pelvic joints in pregnancy may also have more remote consequences is suggested by the fact that not infrequently chronic backache in women is found to have originated following parturition. One may recall that the work of Goldthwait and Osgood establishing the entity and symptomatology of disturbances of the sacro-iliac joints owed its origin in part to observation of those joints during pregnancy.

The purpose of this paper is to make a preliminary report of the results of studies still in progress at the Boston Lying-In Hospital centering around the general subject of pelvic joint relaxation in pregnancy.

## REVIEW OF THE LITERATURE

Although it is full of interest, it is unnecessary to enter into a review of the early history of the subject, since this has been fully covered in articles by Snelling 1870, Cantin 1899, Lynch, 1920, Boland, 1932, and Heyman and Lundquist, 1932. A great controversy was engaged from earliest times over the Hippocratic theory of "disjunctio pelvis." Contributions were made to it by numerous authors including Vesalius, Severin, Pineau, Ambroise Paré, Albinus of Leyden, William Hunter, Velpeau, Jacquemier, Baudelocque, Lenoir, Luschka, and many others. Their views differed markedly, some believing that pelvic joint relaxation was a normal and constant phenomena, others that it was exceptional and pathological. During the last century most authors have accepted the view that the pelvic joints softened and became relaxed during the pregnant state, but no accurate

studies have been made of the frequency and degree of separation until the recent article by Heyman and Lundquist, 1932, which appeared subsequent to the beginning of our own studies.

Interesting parallels have been found among various mammals. In 1812 LeGallois described the mechanism in the female guinea pig which permitted the delivery of a fetus with a head of an average diameter of 20 millimeters from a pelvic outlet with an average normal diameter of 11 millimeters. Three weeks before term the pubic ligaments became thick and malleable and allowed the symphysis to separate a distance of 1 to 2 fingers' breadth. Shrinkage began immediately following delivery, and within a few days the symphysis receded to normal width and consistency. Similar processes have been described in the seal (Barlow), the pocket gopher (Hisaw) and the cow (Knox). In the latter animal the relaxation chiefly affects the sacro-iliac joints.

There has been considerable discussion of the mechanism by which relaxation in women is brought about. Some writers observed that the joints became swollen to the extent of a third or even one half greater than their normal volume. Stoltz considered this to be definitely pathological and that it served no physiological purpose. Luschka (18) believed that the symphysis pubis was an incomplete joint, and that during pregnancy it became distended by a copious secretion of synovial fluid. Snelling concluded that a certain degree of relaxation occurred as a purely physiological mechanism, but that beyond a certain limit the process became pathological in that the ligaments became saturated with serum, lost their firm and resilient qualities and the amount of synovial fluid was greatly increased. This initiated a train of symptoms which was due to the inability of the pelvis in its relaxed state to sustain the general body weight.



Cantin in 1899 reported that he found tactile evidence of relaxation of the symphysis pubis in 408 out of 500 pregnant women examined and that the degree of separation varied from 1 to 3 millimeters. He was able to demonstrate mobility at the symphysis in all but 3 per cent. His studies were made without the aid of roentgen examination. He stated that of all the ills of pregnant women there was none more common or more frequently overlooked than relaxation of the pelvic joints.

Heyman and Lundquist made a study of the width of the symphysis pubis in pregnant and non pregnant individuals using an accurate method of roentgenological measurement. They reported a large series of measurements as follows:

Control series (I) 70 normal nulliparae aged 19 to 42 years of which 80 per cent showed a width of the pubic gap of 5 millimeters or less (II) 392 non-pregnant women aged 5 to 80 years of which 84 per cent had measurements of 5 millimeters or less (III) 368 males aged 5 to 80 years of which 90 per cent showed measurements of 5 millimeters or less. (In each of these three groups there were only a few individuals who showed measurements of over 6 millimeters) (IV) 74 women who were pregnant aged 19 to 30 years of which 48 were primiparae and 26 multiparae.

They noted an increase in width of symphysis of usually 1 to 2 millimeters with a maximum of 4 millimeters. The average width was between 7 and 8 millimeters and the maximum 12 millimeters.

They concluded that an increase in the width of the symphysis pubis occurred in all pregnant women that the increase antepartum was not as great as the decrease postpartum but explained this as due to the fact that no measurements were made before the fifth month of pregnancy. They did not believe that any increase took place in the last 3 months of pregnancy or during the course of labor. The greatest increase was observed to occur between the fifth and seventh months of the antepartum period. They considered that the widening of the symphysis was brought about by an active biological process, begun in the early stages of pregnancy and

tending together with similar changes affecting the sacro-iliac joints to increase the roominess of the pelvis.

In respect to the instances of wide pubic separation that have been occasionally encountered these have generally been ascribed to the effects of trauma either preceding or accompanying parturition. A number of authors have written on this subject and published case reports. The symptoms due to pelvic instability have been described. Lynch, in 1920 made a roentgenological examination of pelvic joints during labor without reaching any definite conclusion. Only one of the women showed marked widening of the symphysis with a return to normal when examined 15 months later. He noted constant widening of the sacro-iliac joint spaces. Brehm and Weirauch, in 1928 reported 54 cases of pubic separation. They attempted to establish normal and abnormal degrees of separation. They stated that patients with a gap of under 8 millimeters or less showed no symptoms of pelvic instability; those with a gap of from 9 to 20 millimeters had slight symptoms, and those with measurements of over 20 millimeters had marked symptoms. Lieh-Chung Wu in 1930 reported 3 cases and attributed the condition to mechanical causes or instrumental delivery and also questioned the presence of weakness of the pelvic ligaments of congenital origin.

Reis, Baer, Arena, and Stewart, in 1932 were able to collect from the literature reports of 62 cases with pubic separation to which they added 5 of their own. They did not believe that any characteristic changes occurred at the symphysis as a result of pregnancy and were unable to demonstrate in 80 consecutive cases by roentgenological examination any difference in the appearance of the pubic gap from that of normal non-pregnant women. They attributed all instances of pubic separation to mechanical causes, to marked intensity of uterine contraction, rapidity of labor and to disproportion between the size of the fetus and of the pelvic outlet.

Numerous articles have also been published dealing with the gross and microscopic anatomical changes in the symphysis pubis, the most complete of which is that of Putschar

He described the appearance of the joint at different ages and in pregnant and non pregnant individuals. He pointed out the constancy of the cleft formation both in males and females and attributed the changes during pregnancy to the extensive loss of the interosseous cartilage and the development of a genuine joint

#### PLAN OF STUDY

Our own attention was first directed toward the need for study of the changes in the pelvic joints during pregnancy by the finding of wide separation of the pubis in several women who were examined 1 to 2 weeks following delivery because of the development of painful symptoms. We accepted the usual explanation of trauma during delivery to account for the condition. Shortly afterward, however, one of us observed a similar condition in a patient who had only reached the sixth month of pregnancy, and in whom we were able to exclude any possible relationship to trauma. Plans for a co-operative orthopedic and obstetrical investigation of the condition were then made.

A review was made of a number of X ray films of the pelvis made during pregnancy that were found in the files of the Roentgen Department. This showed that little measurable change could be demonstrated in the sacro-iliac joints, but that on the other hand marked changes could be noted at the symphysis pubis. This determined our plan to use the width of the symphysis pubis as an index of relaxation of the pelvic joints and to compare the width in pregnant women with that of non pregnant controls. Various side lines of interest have developed during the study, and it is our hope that we may be able to follow these up and make additional reports of the results later

#### ANATOMY OF THE SYMPHYSIS PUBIS

It is stated in Cunningham's *Text Book of Anatomy* that the symphysis pubis is an amphiarthrosis and that each pubic bone is covered by a layer of hyaline cartilage. Between these two hyaline plates there is interposed a disk of fibrocartilage in the interior of which there is usually a vertical antero-posterior cleft. This cavity is placed nearer

the posterior than the anterior aspect of the joint, and does not appear until between the seventh and tenth years of life. It is not lined by any synovial stratum and is supposed to result from the breaking down of the interpubic laminae. There are four ligaments, the anterior, the posterior, the superior and the arcuate. The anterior ligament is of considerable thickness and strength, its fibers forming an interlaced decussation. The posterior ligament is very weak and consists of scattered fibers running transversely. The superior ligament is also weak, and is made up of transverse fibers passing between the two pubic crests. The arcuate ligament is of considerable strength and occupies the arch of the pubis. It gives roundness to the pubic arch and forms part of the boundary of the inferior aperture of the pelvis.

At birth the rami of the pubis are well ossified but the descending rami are joined to the ascending rami of the ischium by a band of cartilage which becomes completely ossified at about the eighth year or earlier. The suture line may be visible as an indentation up to the eighteenth year. The symphyseal space is occupied by a solid mass of cartilage and is much wider than in adult life. Gradually this is narrowed by advancing ossification of the central margins of the pubic bones until it is reduced to its fixed adult size at about the twentieth year. Actually ossification may continue up to the twenty fifth year as shown by our roentgenologic measurements which were always wider in the third than in the later decades due to the inclusion of a few cases in which the development was still incomplete.

#### METHODS OF ROENTGENOLOGICAL MEASUREMENT

It first became necessary to find out what degree of error existed in making direct measurements of the width of the symphysis pubis on flat X ray films and whether a special technique would have to be employed. We made use of the method of stereorontgenometry described by Clayton Johnson to check up on this point. The technique of this method has been fully described and will not be repeated here. It is sufficient to state that

TABLE L.—CONTROL SERIES, NORMAL NON PREGNANT FEMALES

X-ray measurements of symphysis in 123 individuals

Width of symphysis in mm.			3	4	5	6	7	8	Total	Average mm.
Age	Nulliparae									
21-30			2	14	4				22	4.
31-40				3					9	4
41-50								9		
51-60										
Totals			7	9	5				21	4.09
	Primiparae									
21-30					4				7	4.3
31-40				6	2					4.00
41-50										
51-60										
Totals				6	7				13	4.15
	Multiparae									
21-30					3				3	3.4
31-40				11	13	8			32	4.6
41-50			7	6	8				21	4.4
51-60										
61-70										
Totals			10	19	21	8	3		71	4.6

It is a method of accurately localizing and determining the dimensions of any radio-opaque substance in the body from its stereoscopic roentgenograms.

Measurements of the width of the symphysis pubis were made by this method in 25 pregnant women who showed varying amounts of separation. Comparison was then made between these measurements and those obtained by direct measurement on the film of the distance between the pubic bones. The variation in all cases was found to be trifling never amounting to more than 1 millimeter and for practical purposes and especially for comparison of relative changes, it seemed to us that the simpler method of direct measurement could be accepted as reasonably accurate. A fixed distance between tube target and film is of course necessary and for this purpose we routinely employed a distance of 30 inches.

An opportunity for error by this method lies in irregularity of the pubic bones, more marked in some cases than in others, and also in the varying obliquity of the pelvic axis. Since the pregnant woman finds it difficult to lie in the ventral position roentgenograms of the symphysis must be made with the patient lying on her back. In most of the patients the axis of the pelvic canal is oblique from above downward and backward but there results a fair anteroposterior projection of the pubic bones upon the film and the width of the symphysis can be readily determined. In other cases the pelvis is more tipped and the axis of the pelvic canal is almost horizontal so that the projection of the pubic bones upon the film is in the vertical diameter instead of anteroposterior. In these cases there is always a large amount of superimposed shadow which makes it difficult to determine accurately the limits of the pubic gap but the

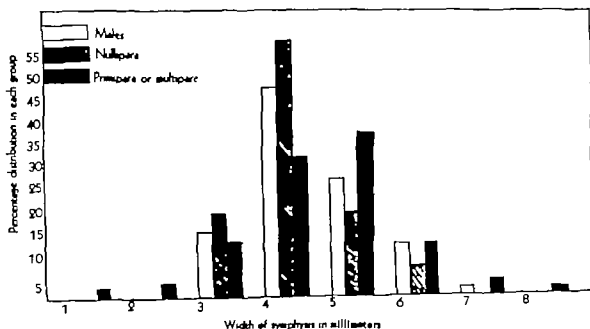


Fig. 1 Composite table showing comparative symphyseal measurements in groups of males, nulliparae and non pregnant primiparae or multiparae women.

effect of this is always to narrow and never to widen the symphysis so that measurements by this method are never exaggerated. We marked the edges of the two pubic bones with a pencil at the narrowest diameter of the symphyseal space and measured between these points.

#### NORMAL CONTROL MEASUREMENTS

*1 Females* In order to establish what constituted the normal variation of symphyseal width in non pregnant women a series of measurements were made from a group of pelvic X ray films that had been made for gynecological diagnostic purposes. In this way measurements were obtained of 123 women, comprising 33 nulliparae, 20 uniparae and 70 multiparae. The results are shown in Table I.

From this it will be seen that there was relatively little difference between the width of the symphysis of the various groups: the average for the nulliparae being 4.09 millimeters, for the uniparae 4.15 millimeters, and for the multiparae 4.6 millimeters. The measurements are shown graphically in Figure 1 and study of this chart shows better than the table a definite tendency toward greater width of the symphysis in the multiparae women than in the nulliparae. In the former

the peak is at 5 millimeters while in the latter it is at 4 millimeters. It will also be noted that there is distinctly greater variation in the symphyseal measurements of the women who have borne children. In the nulliparae the measurements varied from 3 to 6 millimeters inclusively while in the multiparae the variation was from 1 to 8 millimeters inclusively.

There was also noted a difference between the appearance of the symphysis in the nulliparae and multiparae women. In the former the outline of the symphyseal margins of the pubic bones was smooth with only a thin cortical layer of increased density. In the multiparae women there appeared to be a definite tendency to greater irregularity of the pubic margins of the symphysis with greater unevenness of the cortical outline and occasionally small round areas of decreased density suggestive of cyst formation. It was frequently possible to tell from the X ray appearance of the symphysis whether or not the woman had previously borne children.

The difference in the measurements and appearance of the symphysis would seem to indicate that pregnancy is usually followed by changes at the symphysis pubis.

Age seemed to have very little influence upon the width of the symphysis; the average for the different decades being approxi-



Fig. 2 X-ray picture of the pelvis of a multiparous woman. The irregularity of the symphysis pubis is to be noted.



Fig. 3 X-ray picture of the pelvis of a multiparous woman. Note the apparent cystic formation of the margin of the symphysis pubis.

mately the same although the number of individuals in the decades above 40 was too small to make the figures reliable on that point. The average width in the 21 to 30 age group is slightly larger because of the inclusion of a few individuals in whom osseous development had not as yet reached the completed stage.

**2 Males.** It also seemed of interest for comparative purposes to study the symphysal pubis in males. A group of pelvic films were examined that had been made for the purpose of genito-urinary diagnosis in 71 individuals. The results are shown in Table II and they have also been included in the graph (Fig. 1) for comparison with the females. As far as the width of the symphysis was concerned there was no difference between the group of

nulliparae and the males. The average width for the entire group was 4.4 millimeters and the variation was from 3 to 6 millimeters with the exception of one individual who measured 7 millimeters. The roentgen appearance of the male symphysis was also similar to that of the nulliparae except for the well known masculine and feminine characteristics of the pelvis itself. The pubic margins were generally smooth and straight. Although there was no difference in the average width between the various decades there were noted slight productive or hypertrophic changes in some of the individuals of advanced years (Fig. 4, A). In one man of 72 there was noted complete bony bridging at the superior margin of the symphysis, but details of the patient's history were lacking (Fig. 4, B).

TABLE II.—CONTROL SERIES—NORMAL MALES

X-ray measurements of symphysis in 71 males

Age	Width of symphysis in millimeters								Total	Average mm.
	3	4	5	6	7	8				
1-20		4						7	4.3	
21-30		6	3						9	
31-40		6						3	3.3	
41-50		6			3			13	4.5	
51-60	3		3					10	4	
7-80			4					7	4.7	
81-90										
Totals	20	11	30	3				71	4.4	



Fig. 4. A. Typical male pelvis. The line of the symphysis pubis is straight. B Male pelvis (age 72). A straight symphysis showing also complete bony bridging.

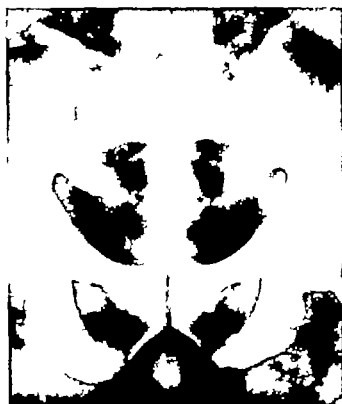


Fig. 4, B

The average measurements of both the women and the men corresponded closely with those reported by Heyman and Lundquist.

#### STUDY OF PREGNANT WOMEN

1 *First group* A series of measurements were made of a group of X ray films of the pelvis that had been made in the last 2 months of pregnancy for the study of fetal measurements. The group comprised 111 individuals

chosen without any selection, and they were not differentiated in respect to parity although the great majority were multiparae. The measurements of the symphysis are shown in Table III.

These showed a very definite increase in the width of the symphysis on the whole and a very marked variation between the individuals. The average width was 7.7 millimeters an increase of 3 millimeters over the average width of a similar non pregnant group (4.6 millimeters). The averages for the

TABLE III.—MEASUREMENTS OF PUBIC WIDTH IN 111 PREGNANT MULTIPARAE—IN LAST TWO MONTHS OF PREGNANCY

Age	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total	Average—mm.
8-20					1	1													2	8
21-24			3	3	4	7	4				1								5	8
25-28				6	1	8	1	3											11	7.3
29-32			5	3	2	6		3											13	7.3
33-36	1		3		4	3	1	1	1	1	1		1	1					20	8.3
37-40							1					1							3	
41-43						3													3	
Totals	3	3		14	2	15	7	9			4	1							11	7.7

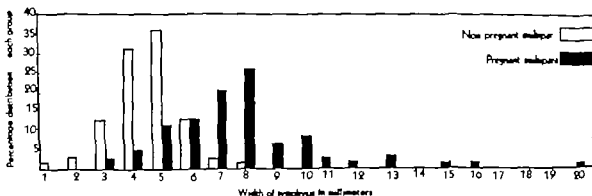


Fig. 5 Composite table showing comparative measurements of width of pubic gap in groups of non pregnant women who have borne children (90 individuals) and similar group of pregnant women (111 individuals). X-ray pictures made in last two months of pregnancy.

different age groups into which the patients were divided showed only slight difference so that age appeared to have very little relation to the changes. The most striking finding was the great degree of variation between the symphyseal width of different individuals which tended to make the average figure unrepresentative of the group. The maximum was 20 millimeters and the minimum 3 millimeters. The width of the symphysis was 9 millimeters or more in 27 or 24.3 per cent. The measurements are shown graphically in comparison with those of a similar control group of non pregnant women (Fig. 5). This makes more apparent the striking shift of the measurements of the symphysis to larger size in pregnancy.

TABLE IV — MEASUREMENTS OF SYMPHYSIS OF 25 CONSECUTIVE PRIMIPARÆ

Cases	Width of symphysis mm.	Age	Time of examination before delivery
		20	42 days
3	3	5, 20, 5	day 59 days, 90 days
	6	26	Probably about month
6	7	18, 18, 9 9, 20,	14 days, 27 days, 48 days 3 days, 44 days, 70 days
7	8	8, 20, 2, 2, 26 27	44 days, 28 days, 43 days 3 days, 3 days, 23 days 7 days
4	9	18, 7 20, 30	14 days, 43 days 27 days, 26 days
	1	26	14 days
	13	3	day
	14	20	26 days

2 *Second group* In order to get a better idea of the incidence and degree of pubic separation and to see what part previous pregnancies played in weakening the articulations and whether this accounted for the large number of patients with abnormally wide separation in the multiparous group roentgenological measurements were made of a group of 25 primiparae in their last 2 months of pregnancy. These patients were chosen consecutively as they presented themselves at the clinic so that there was no selection and the measurements present as nearly as the small size of the group permits a true cross section of all primiparae. The measurements are shown in Table IV. They are also represented graphically in comparison with those of a similar control group of non-pregnant nulliparae (Fig. 6).

The average of the 25 measurements was 7.9 millimeters which agrees closely with the average of 7.7 millimeters obtained in the multiparae (Group 1). In this group 7 or 28 per cent measured 9 millimeters or over which compares with 24.3 per cent for the multiparous group. Here again the study seemed to show that the symphyseal widening occurred independently of any relation to age.

The measurements of the primiparae are compared on a percentage basis with those of the multiparae in Table V and the comparison is also shown graphically (Fig. 7). We may conclude from the study of these two groups that there is no essential difference

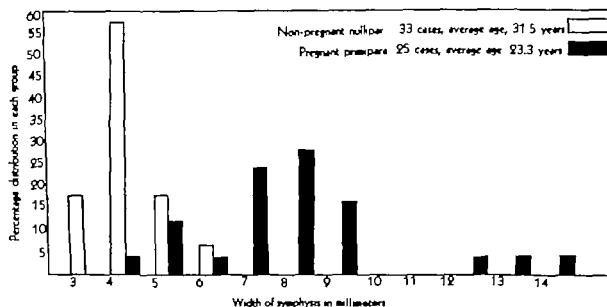


Fig. 6 Composite table showing comparative symphyseal measurements in groups of non-pregnant nulliparous and of pregnant primiparous in last month of pregnancy

between the behavior of the pubic articulation in primiparous and multiparous that the symphysis regularly undergoes relaxation with an average increase of width of 3 to 4 millimeters, but that in about 25 per cent of individuals for some unknown reason the relaxation becomes much greater than this sufficient in fact to be considered a pathological separation.

**3 Third group** Finally an attempt was made to obtain consecutive roentgenological measurements at different periods both antepartum and postpartum in a group of pregnant women. This group comprised 38 individuals with 93 observations chiefly patients who complained of symptoms that were thought to be due to pelvic instability or others in whom pubic separation was suspected because of the clinical findings at the time of examination. In spite of special efforts that were made to follow these patients some were lost and no additional measurements obtained. Also some were only seen for the first time following delivery when symptoms referable to the pelvis were first noted. In these cases antepartum X-ray films showing the symphysis were generally lacking and earlier measurements of the width of the symphysis could not be obtained. Although the data are incomplete they yield considerable information in respect to the

TABLE V — PUBIC MEASUREMENTS OF PRIMIPARAE AND MULTIPARAE MADE BY X-RAY EXAMINATION IN LAST TWO MONTHS OF PREGNANCY

Width of pubic—mm.	Primiparae		Multiparae	
	N	Per cent	No.	Per cent
3	0	0	1	7
4		4	5	4.5
5	3		3	8
6		4	4	6
7	6	24	3	20
8	7	28	28	3
9	4	16	7	6.3
	0		9	8
	0	0		8
		4	3	9
3		4	4	3.6
14		4		9
5				9
16	0	0		9
7	0			0
8		0		0
10	0	0		
10		0		8
Totals	1	100		100
Antepartum	79		77	



TABLE VI—MEASUREMENTS OF 35 PREGNANT WOMEN AT DIFFERENT PERIODS, ANTE-AND POSTPARTUM

Parity	Symptoms	Onset of symptoms	Months of pregnancy						Delivery	First month		Months postpartum													
			IV	V	VI	VII	VIII	IX		1-14 days	15-28	1	2	3	4	5	6	7	8	9	10				14
I	Pubic	works post partum									5														3
III	Nausea											3								2					
III	Pubic and back	9th mo	5								3				4										
III	Sacro iliac	6th mo									3														
I	Sacro iliac	8th mo									6														4
II	Sacro iliac and pubic	6th mo				6				6				5								4			
II	Pubic	5th mo								7															
II	Nausea									7															
V	Sacro iliac	7th mo				7								3											
I	Sacro iliac and pubic	9th mo								7															
IV	Pubic	2nd mo				7				7	5			5							2				
III	Pubic	8th mo					8			7															
I	Nausea					7				9				6				5							
I	Sacro iliac and pubic	9th mo					9			9			6				6								
I	Sacro iliac	9th mo								8															
I	Low back	8th mo		1						8															
I	Pubic	9th mo					7																		
III	Low back	5th mo			8										5										
II	Sacro iliac	9th mo				9				8															
II	Sacro iliac and pubic	9th mo					9				7														
I	Sacro iliac and pubic	9th mo					9																		
III	Sacro iliac and pubic	8th mo					9										7								
III	Sacro iliac	8th mo													3										
IV	Sacro iliac	8th mo			10								6			5									
III	Sacro iliac and pubic	6th mo											3						3						
III	Sacro iliac	8th mo																							
IV	Sacro iliac and pubic	8th mo																							
III	Sacro iliac and pubic	8th mo																							
V	Sacro iliac and pubic	11th mo																				6			
IV	Sacro iliac	7th mo															8								
I	Sacro iliac	8th mo								11						5									
I	Sacro iliac and pubic	4th mo									7								3						
V										3	16														
I	Pubic	Post partum										3			9										
II	Pubic	11th mo.								17	6	66			4	5									

Developed osteomyelitis of symphysis after delivery

TABLE VI.—MEASUREMENTS OF 38 PREGNANT WOMEN AT DIFFERENT PERIODS  
 ANTE-AND POSTPARTUM—Continued

Partly	Symptoms	Onset of symptoms	Months of pregnancy						Delivery	First month		Months postpartum															
			IV	V	VI	VII	VIII	IX		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
III	Sacro-iliac and pubic	4th mo.	6				8			14	3																
II	Sacro-iliac and pubic	8th mo.		13						18			8														
IX twice	None						24			25	10	10	8½				8										

development and retrogression of the process of pubic relaxation (Table VI and Fig 8)

As to the period of pregnancy in which relaxation of the symphysis begins this is evidently early. The earliest measurements were made in the fourth month and then only in two individuals but in both the width was greater than that to which the symphysis retrogressed later so that we considered some degree of relaxation was already present. Wide measurements indicative of relaxation were obtained in one of two individuals examined in the fifth month and in all of the 5 women who were examined in the sixth month. The observations are meager but they indicate that the process begins in the first half of pregnancy.

The measurements further show very little tendency to increase of the relaxation in the last 2 or 3 months of pregnancy. The process of parturition seems to have very little effect in increasing the width of the symphysis. Of 15 patients in whom comparative measurements were obtained both antepartum and within a few days after delivery, the width of the symphysis increased in 9, remained stationary in 1 and diminished in 5. The increase amounted to 1 to 2 millimeters in 7, and to 5 millimeters in 2 individuals but in both of the latter patients the previous measurements had been made in the sixth month and we have no knowledge of the amount of widening of the symphysis that had occurred in the meantime.

Retrogression of the symphyseal relaxation began in the first month postpartum and apparently was fairly well complete by the end of 3 to 5 months. An artificial factor enters in here as most of the patients with wide separation were treated by various

orthopedic appliances, and it is impossible to determine in what degree the results were modified by the treatment.

Comparing the measurements of those in individuals in whom both antepartum and late postpartum examinations were obtained we have evidence of retrogression amounting to 1 millimeter in 1 patient, 2 millimeters in 3, 3 millimeters in 2, 4 millimeters in 1, 5 millimeters in 3, 6 millimeters in 1, 7 millimeters in 2, 8 millimeters in 1, 15 millimeters in 1, and 26 millimeters in 1. The average was 7.7 millimeters, decrease from the maximum width. The general course of relaxation and retrogression of the symphysis is shown in Figure 8 in which the consecutive measurements of 20 patients are plotted in individual curves.

4 *Roentgen appearance of symphysis* Slight but definite changes in the appearance of the symphysis during pregnancy apart from the separation were shown by roentgenological examination. These seemed to consist in thinning and absorption of the cortical layer at the pubic margins, the development of slight proliferative changes tending to give an appearance of greater irregularity to the symphyseal space and the occasional appearance of small, round cyst like areas of diminished density in the body of the pubic bone.

5 *Pubic mobility* Movement of one pubic bone upon the other could almost invariably be demonstrated by tactile examination with the patient lying on her back, the examining finger on the symphysis and an assistant simultaneously pushing on one leg and pulling on the other and then reversing the procedure. Pubic mobility could also be demonstrated by X ray examination with the aid of this "push and pull test." Two films were exposed one

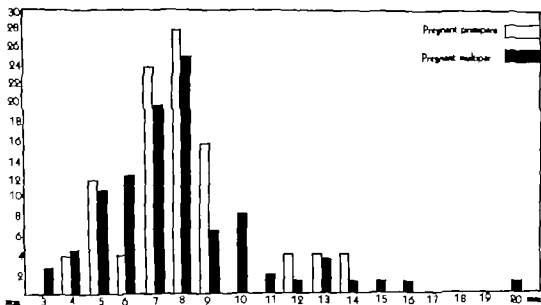


Fig. 7 Comparison between pubic width of pregnant primiparae (ss) and pregnant multiparae (t) Measurements made in last months of pregnancy

with a push on the right leg and a pull on the other and the second with the push and pull reversed. The amount of the excursion varied with the degree of pubic separation being greatest in the patients with the wide gaps. It was difficult to measure the amount of the motion accurately and this was not done (Fig 9).

We have since become familiar with the technique described by Chamberlain for measuring pubic mobility in which roentgenograms are made with the patient, standing upon a wooden block, bearing weight first upon the right and then upon the left leg with the other leg hanging free. This is a better method than the one we employed and we shall make use of it in the future. Control tests using this method were made in 4 males between 25 and 32 years of age and in 5 non-pregnant nulliparae between the ages of 21 and 33 years. In 2 of the males we were able to demonstrate mobility with an excursion of 0.5 to 2 millimeters, respectively and also in 3 of the females the excursion being 1.1 and 2 millimeters, respectively.

Chamberlain uses the method for testing relaxation of the sacro-iliac joints and states that there is usually no measurable displacement in the male but motion up to 0.5 milli-

meter is considered within normal limits in the female the motion may be as much as 1.5 millimeters though 1 millimeter is more usual. He also says that very early in pregnancy the pelvic joints become relaxed thus permitting greater mobility. He considers increased pubic mobility one of the earliest signs of pregnancy.

#### CAUSATION

The constancy of the phenomena of widening of the symphysis pubis in pregnancy as shown by these studies the demonstration that the process begins in the first half of pregnancy and is already established by the end of the fifth to seventh month before pressure forces can have developed to any sufficient extent to play any part in determining the condition and the gradual retrogression of the process within a few months following the termination of pregnancy all point to the biological nature of the process and permit the inference that the regulatory mechanism may be hormonal in nature.

The investigations of F. L. Hisaw of the University of Wisconsin have demonstrated beyond doubt the hormonal control of this process in certain mammals. He was able to demonstrate the presence of a hormone in the blood of guinea pigs, dogs, cats, sows, mares,

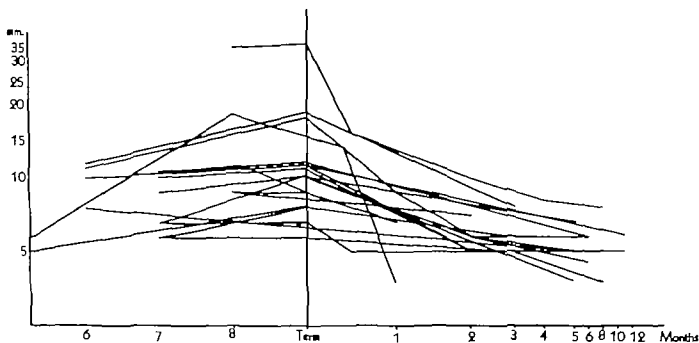


Fig. 8. Consecutive measurement both antepartum and postpartum in 20 pregnant individuals

and rabbits during pregnancy which when injected into virgin guinea pigs during estrus would produce within 8 to 12 hours the same remarkable relaxation of the pelvic ligaments noted in those animals before parturition. In the rabbit this substance could be demonstrated 7 to 8 days after the beginning of pregnancy. It reached its maximum concentration by the twentieth day and was completely absent 12 to 18 hours after parturition. Later this substance was obtained in abundance from the placenta and corpus luteum of the sow. Subsequently he isolated the substance in relatively pure form and named it *relaxin*. He was able to show that it is a special fraction of the corpus luteum hormone.

Hisaw found that the maximum response to *relaxin* occurred only during or close to estrus. Castrated females did not respond unless first brought under the influence of the follicular hormone theelin. He therefore concluded that neither theelin nor *relaxin* could alone elicit relaxation of the pelvis but that the reaction was due to a "one two synergistic relationship between the two hormones." This "one two" relationship has also been demonstrated in male guinea pigs in which the pubic bones are united by cartilaginous substance rather than by ligaments as in the mature

females. By bringing castrated male animals under the influence of theelin he was able to convert the male symphysis into the feminine type and *relaxin* was then able to induce ligamentous relaxation as in females.

Study of the changes at the symphysis showed that two processes were involved in the ligamentous relaxation. Theelin produced a multiplication of the connective tissue elements of the symphysis pubis while *relaxin* caused a shift of the ligaments and rapid relaxation.

Attempts to demonstrate the presence of *relaxin* in the blood of pregnant women have thus far proved unsuccessful and the same is also true in the case of cows. Hisaw came to the conclusion that while many mammals have special pelvic modifications to facilitate parturition it is known that several of them must be accounted for on other grounds than those presented by the guinea pig. The facts indicate that the situation has been met in different biological ways which may or may not include hormonal activity.

To our minds however, the facts concerning the process of symphyseal relaxation in pregnant women indicate a very close parallel to those found by Hisaw in certain mammals and strongly suggest some type of hormonal control.



A.



C.



B

Fig. 9. X-ray pictures demonstrating mobility of the symphysis pubes in a woman near term. A. Patient flat on the table without traction on either hip. B. X-ray picture with traction on the right hip and counter pressure upward on the left hip. Note that the left side of the symphysis is higher than the right. C. Roentgenogram with traction on the left and counter pressure on the right. Note that the right side of the symphysis is now the higher.

#### ABNORMAL WIDENING OF THE SYMPHYSIS

Our measurements of the symphysis in pregnant women showed a number of instances in which the process of relaxation had gone to extreme limits. We previously referred to these as pathological. We believe that they deserve this appellation because they represent actual separation of the pubic bones instead of mere relaxation of the joints and because they are usually associated with symptoms of pelvic instability. Yet they are different in degree only and can be divided only by setting up an arbitrary standard of measurement. If 8 millimeters is taken as the upper limit of normal physiological relaxation then we find that approximately 25 per cent of pregnant women show abnormal widening. In the cases studied by us all degrees of separation were found with an extreme of 35 millimeters, or four times the normal.

These instances of wide pubic separation are the ones that have usually been reported in the literature as examples of traumatic rupture due to falls or other injuries in the antepartum period or resulting from operative delivery or difficult labors of one kind or another. Traumatic rupture undoubtedly occurs, but we believe that it is rare and only one instance of it was encountered during our

study. In this case following the low application of forceps while strong traction was being exerted a loud snap was heard and separation of the symphysis could then be demonstrated. We believe that the diagnosis of traumatic rupture is only justified when a direct sequential relationship between trauma and pubic separation can be shown as in this case.

As to the cause of abnormally wide separation we believe that there is no reason to suppose that it results from anything more than the normal physiological process which becomes exaggerated in certain individuals. It is a possible theory that it is due to an excess in the amount of the regulating hormone. That the stress and strain thrown upon the pelvic joints by the patient's activities, occupation and weight may play part in causing further stretching of the ligaments is possible but it is improbable that this would produce any effect unless the ground had already been prepared by the physiological processes. Also to be considered is the possible effect upon the weakened pubic ligaments of pressure forces exerted by the contents of the uterus. In favor of this is the observation that the widest separation encountered in our series was in a woman with a twin pregnancy but on the other hand the fact that the measurement was already 34 millimeters in the seventh month and that it did not increase thereafter during the period in which the uterine contents greatly enlarged would argue against this playing any

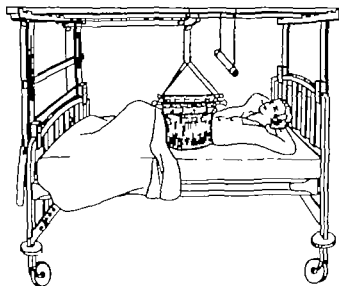


Fig. 10. Drawing of patient in muslin sling suspended by an overhead frame by two weights of approximately 50 pounds each.

great part. Also contradicting this theory was the case of a woman delivered of an anencephalic monster with an associated hydramnios of marked degree who showed a maximum separation of only 8 millimeters.

#### SIGNS AND SYMPTOMS OF PELVIC INSTABILITY

Many pregnant women complain of symptoms that are directly referable to the stretching of the pelvic joint ligaments and the ensuing pelvic instability. The true significance of these symptoms is not generally appreciated and they are classed as part of the general and necessary discomforts of pregnancy. Numerous examples were encountered as soon as we began to question patients. Within a period of 3 months one of us was able to collect 33 cases.

The symptoms may be referable to the pubic joint alone to the sacro-iliac joints alone or to a combination of both. The pubic symptoms are the more common and consist of pain in the region of the symphysis, occasionally referred down the inner side of the thighs usually worse when beginning to move after sitting or lying. There may be a sensation of snapping or movement of the bones when walking and there is frequently complaint of inability to walk normally. The sacro-iliac symptoms are chiefly backache and pain localized over one or both sacro-iliac joints. Pain of the sciatic type referred down the leg

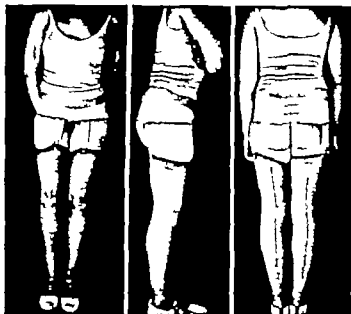


Fig. 11. Pelvic belt worn by ambulatory patients after sling treatment in bed. It can be used for bed treatment in mild cases.

occurs but was encountered in only one patient of our series and then postpartum and following a complicating pneumonia. In a certain number of patients both groups of symptoms are present in combination.

On examination a waddling gait is frequently noted and in the patients showing this a positive Trendelenburg sign can usually be demonstrated that is when the patient stands on one leg there is inability to hold the pelvis in the horizontal plane and the opposite buttock drops. This may be present on one or both sides. Palpation of the symphysis shows marked localized tenderness, this being one of the most constant findings. Depending upon the degree of separation the presence of a sulcus at the symphysis may be noted. In some cases one or even two fingers may be laid between the pubic bones. This is even more marked on bimanual examination. Pubic mobility may be demonstrated by the "push and pull test" upon the legs performed by an assistant. In the patients with sacro-iliac symptoms tenderness on pressure can be demonstrated over the posterior sacro-iliac ligaments and in the region of the sacro-sciatic notch. Motions of the hips are usually free but occasionally limited because of pain in the region of the sacro-iliac or pubic joints on extension from the flexed position. We rarely

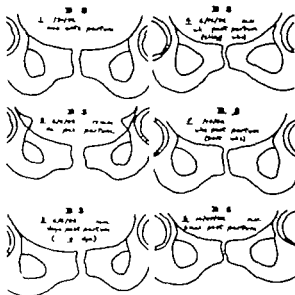


Fig. 12. X-ray tracings of a woman in her second pregnancy. Delivery June 1, 1932. There was marked mobility of the symphysis and X-ray examination suggested widening of the sacro-iliac joints. Placed in sling for 3 weeks after which symphysis returned to normal.

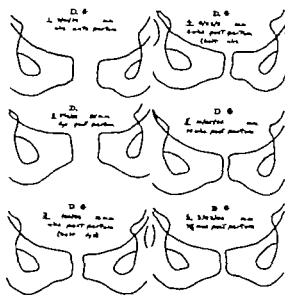


Fig. 13. X-ray tracings of a woman in her ninth pregnancy (twins). Delivery took place on August 6, 1932. There was marked mobility of the symphysis. The patient wore a belt for a period of 4 months following delivery.

found any restriction or pain on flexing the hips with the knees extended.

While the severity of the symptoms corresponded in a general way to the amount of separation of the symphysis that could be demonstrated by X-ray this relationship was by no means constant. Several women in whom no more than the average amount of relaxation was present complained of symptoms and some of the patients in whom marked separation occurred made no complaint whatever. A striking instance of this was the woman with the maximum separation of 35 millimeters and twins. She was in her ninth pregnancy and walked with a marked waddle but had no complaints. She was a large rather stolid woman who had become more or less philosophical about child bearing and most women in her situation would probably have had many and bitter complaints. It was also noticed that in the case of the women who complained of symptoms but in whom only slight or average relaxation of the symphysis could be demonstrated the symptoms were more apt to be sacro-iliac in nature than pubic. In the women with marked separation the symptoms were more often pubic.

Of 30 cases examined because of pelvic symptoms palpable mobility at the pubis was demonstrated in 28. Pubic tenderness was present in 25 and a waddling gait was noted in 13. The separation of the symphysis in the latter cases was distinctly greater than the average 7 measuring over 10 millimeters, and only 2 showing little or no separation.

The onset of symptoms was noted in the second month of pregnancy in 1 instance, in the fourth month in 2, the fifth month in 4, and in the sixth month in 3. The great majority (20) first began to complain in the last 3 months of pregnancy. Several of the women complained of pelvic symptoms only following delivery and pubic separation was then demonstrated by X-ray examination.

Twenty-four women with pubic separation who had had previous children were questioned in regard to the occurrence of pelvic symptoms in former pregnancies. About half (11) had had no symptoms. Of the remainder 7 had had pain in the pubic region, 6 sacro-iliac symptoms, and 2 had had discomfort in both regions. One woman gave a definite history of former pubic separation and had received orthopedic treatment. Her sym-

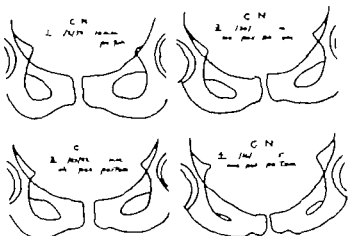


Fig. 14. X ray tracings of a woman in her second pregnancy. Delivery June 25 1932. X ray films showed both absorptive and productive changes.

physis came apart in the seventh month of her subsequent pregnancy and she suffered from great discomfort due to this cause.

#### TREATMENT OF PELVIC JOINT RELAXATION

In view of the fact that pelvic joint relaxation is a normal physiological accompaniment of pregnancy the question will be asked whether any treatment is indicated and to this we would reply in the affirmative. Treatment is indicated in the antepartum period to relieve symptoms and to increase the patient's comfort. Further it may limit the amount of symphyseal widening and prevent it from reaching the stage of pathological separation. In the postpartum period early intensive treatment will quickly bring about closure of the symphysis and prevent the development of a condition of chronic relaxation of the pelvic joints. The frequent prelude to chronic backache, recurrent sacro-iliac strains and other conditions that account for a great deal of later discomfort among women who have borne children.

In the antepartum period treatment is indicated only when the patient complains of symptoms referable to the pelvic joints or when evidence of abnormal widening of the symphysis is found on examination. Since the latter condition may develop in the absence of symptoms the obstetrician should systematically include the symphysis pubis in his general routine of examination of the pregnant patient. When in doubt as to the exact condition he should have recourse to the help

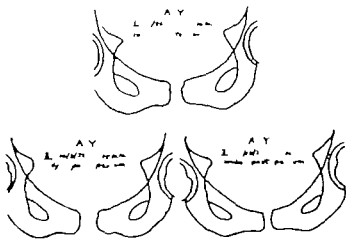


Fig. 15. X ray tracings of woman in second pregnancy. Delivery October 1 1932. Marked mobility of symphysis, cystic changes (not shown in tracings).

of the roentgen ray. For treatment at this period we have employed a simple type of webbing belt (Fig. 11) which makes pressure only about the pelvis and the patients have generally obtained prompt relief from its use. Adhesive strapping may be used as a less efficient and less comfortable substitute.

It is in the immediate postpartum period however that treatment is most urgently indicated. Retrogression of the pelvic joint relaxation begins immediately following delivery and proceeds slowly over a period of several months before reaching a static condition. When an abnormal degree of separation of the symphysis pubis exists and the patient is allowed to become ambulatory there is danger that the excessive mobility of the bones together with the stress and strain thrown upon the joint by the patient's activities may interfere with the normal involution and that a condition of chronic relaxation may persist. This condition was observed in 3 patients of our series who did not receive any treatment. In 1 the symphysis retrogressed to a width of 12 millimeters at the end of 10 months and she still complained of pain at the pubis, in another to 8 millimeters at the end of 3 months and in a third only to 9 millimeters at the end of 4 months during which time she had been almost entirely disabled.

On the other hand with prompt recognition of the condition at the time of delivery and immediate institution of treatment while the patient is recumbent the pubic bones can be



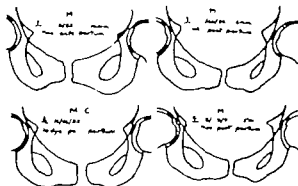


Fig 16. X-ray tracings of a woman in her fourth pregnancy. Delivery took place on November 5, 1932. The patient showed marked mobility and some cystic irregularity of the symphysis (this is not shown in the tracings).

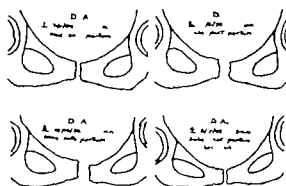


Fig 17. X-ray tracings of a woman in her third pregnancy. Delivery on January 24, 1933. Two weeks after delivery she was placed in a sling, following which the belt. Closure of the symphysis did not occur until treatment was begun and then progressed rapidly.

approximated promptly and the ligaments permitted to tighten to the utmost while still malleable. The most efficient appliance for overcoming the separation and also the most comfortable is the muslin sling suspended from an overhead frame by two weights of approximately 20 pounds each (Fig 10). This apparatus promptly brought about closure of the symphysis when employed by us and at the end of the usual postpartum recumbent period of 2 weeks the ligamentous slack had been taken up sufficiently to permit the patients to become ambulatory with the support of a pelvic belt (Fig 11) without any recurrence of the separation.

Here again everything hinges upon an early recognition of the separation. The obstetrician has an unequalled opportunity at the time of delivery to examine the symphysis pubis and to ascertain the degree of separation that is present. When in doubt he can always fall back upon X-ray examination to settle the question. (Figures 12 to 17 show series of typical cases with abnormal separation of the symphysis pubis. The X-ray tracings show the changes that occur before and after delivery with the amount of separation measured in millimeters. When treatment was given it is indicated.)

#### CONCLUSIONS

1. Relaxation of the pelvic joints and particularly of the symphysis pubis is a normal accompaniment of pregnancy.

2. Relaxation of the symphysis begins in the first half of pregnancy progresses but slightly in the last 3 months and is but little affected by parturition. Retrogression begins immediately following delivery and is usually complete by the end of 3 to 5 months.

3. The process of relaxation is physiologic and is probably the result of a hormonal activity.

4. Abnormal separation of the symphysis pubis occurs in about 25 per cent of the cases and probably results simply from an exaggeration of the normal physiological process; only exceptionally does trauma play any part.

5. Symphyseal relaxation is accompanied by an increase of pelvic mobility and is frequently associated with characteristic symptoms resulting from instability of the pelvic joints.

6. Treatment is indicated to relieve symptoms and to prevent the development of a condition of chronic relaxation of the pelvic joints which is frequently responsible for a great deal of later discomfort among women who have borne children.

7. The key to the situation lies in prompt recognition of abnormal separation of the symphysis when present, and in order to detect this the obstetrician should include the symphysis pubis in his regular routine of examination of the pregnant patient both antepartum and at the time of delivery.

## BIBLIOGRAPHY

## ARTICLES REFERRED TO IN THE TEXT

1. BARLOW Monthly J M Sc. Edinburgh, 1854, p 84.
2. BOLAND, BENEDICT F Separation of symphysis pubis. New England J Med. 1933 cviii, 431.
3. BREHM, W., and WEIZADOCH, H. V. Am. J Obst. & Gynec., 1928 xv.
4. CANTIN LOUIS. Relochement des symphyses et arthralgies pelviennes d'origine gravidique. Thèse de doct. Par 1899.
5. CHAMBERLAIN W E. Symphysis pubis in the roentgen examination of the sacro-iliac joint. Am. J Roentgenol., 1930, xxiv No. 6.
6. CUNNINGHAM, D J Text-book of Anatomy 5th ed. New York William Wood & Co. 1923.
7. FEVOLD H. L., HIRAW F. L., and MEYER, R. K. Proc. Soc. Exper Biol & Med. 1930 xxvii 27.
8. GOLDTHWAIT J E. and OSOONOD R. B. Boston M & S J 1905 ciii, 503.
9. HEYMAN JAMES, and LUNDQUIST, ARVID The symphysis pubis in pregnancy and parturition. Acta obst. et gynec. Scand., 1932 xli.
10. Idem. J Exper Zool. 1925, xlii No 4.
11. Idem. Physiol. Zool. 1929, li, No. 1.
12. Ibid. 1930, lii No 1.
13. HIRAW F. L. Sex and Internal Secretions, 1932.
14. HIRAW et al. J Am. Chem. Soc. 1932 lii.
15. JOHNSON CLAYTON R. Stereoroentgenometry A method for mensuration by means of the Roentgen ray. Am. J Surg. 1930 viii, 151.
16. KNOX. Lancet, 1839, 1840 Med. Gaz. 1843.
17. LE GALLONS. Experiences sur la vie (Appendix) Translated by N. C. and J. G. Nancrede. Philadelphia, 1913.
18. LUSCHKA. Arch. f Gynaek. 1912 xcvi.
19. LYONCH FRANK W The pelvic articulations during pregnancy, labor and the puerperium. Surg. Gynec. & Obst. 1920 xxx 375.
20. PUTSCHER, W. Zur Pathologie der Symphyse. Verhandl. d. deutsch. path. Gesellsch. 1930, xxv 214.
21. REID, BAER, ARENS, and STEWART Traumatic separation of symphysis pubis during spontaneous

labor with clinical and X ray study of normal symphysis pubis during pregnancy and puerperium. Surg., Gynec. & Obst. 1932 lv 336.

22. SKELLING, F. G. Relaxation of the pelvic symphyses during pregnancy and parturition. Am. J Obst. 1870, li, 561.
23. WU LIEH-CHUNG. Nat. M. J China, 1930 xvi.

## ADDITIONAL REFERENCES

1. BAUDELOQUE. Midwifery. Abridgement of Heath's Translation. 3d ed. Edited by Wm. P. Dewees. 1823.
2. DUNCAN. Researches in Obstetrics. Edinburgh, 1868.
3. EISENBERG. Rusts Magazine xvii pt 3 550.
4. EYMER. Die Roentgenstrahlen in Gynaekologie und Geburtshilfe 1913.
5. GRAVES, W. P. Gynecology 4th ed. 1928.
6. Idem. Female Sex Hormonology 1930.
7. HUNTER W. On the symphysis pubis. Medical Observer and Inquirer London 1762 li, No. 28.
8. JACQUEMIER. Manuel des accouchements, li, 476.
9. LACHAPELLE. Pratique des accouchements, lv 85.
10. LANG F. J. and HASLBEYER L. Arch. Surg. 1932 xxiv November.
11. LUSCHKA. Arch. f. path. Anat. 1854, vii.
12. MCNAMARA. Surg. Gynec. & Obst. 1916 xxiii, 625.
13. MUELLER W. Zentralbl. f. Gynaek. 1931 lv.
14. NICHOLSON. Tr. Roy. Soc. Phys. Ireland 1824, iv.
15. POUILLON. De la rupture des articulations du bassin pendant l'accouchement. Lyon méd. 1864.
16. SENOTR. Bull. Acad. nation. de méd., 1851 xvi, 15.
17. SKELLING. Midwifery. New Sydenham Society 1877, li, 5.
18. SPIEGELER. Anat. lib II cap xxiv.
19. TERNIER and CHAMFREUIL. Traité de l'art des accouchements, 1888, i 238.
20. WALTER. Von der Spaltung der Schambein. Berlin 1782.
21. WOOD JOHN. Pelvis. Cyclopaedia of Anatomy and Physiology 1859 v.
22. ZAGLAS. Month. J M Sc. Edin. 1851 September p 289. 1851 November p 489.

## CHRONIC FOLLICULAR GASTRITIS

C. R. K. JOHNSTON, M.D., CLEVELAND, OHIO

Department of Pathology, University of Toronto, and the Toronto General Hospital, Canada

THE operation of gastric resection now largely replacing gastro-enterostomy in the surgical treatment of peptic ulcer has placed valuable fresh material in the hands of the pathologist. As a consequence the study of chronic gastritis has become increasingly popular due chiefly to the continental writers who believe that the workers in the British Isles and this continent pay the subject too little attention. In a recent communication Landau and Wulff sum up the views of the former by saying "undoubtedly the most important observation (i.e. with reference to peptic ulcer) made of late years is the regular appearance in ulcer cases of a gastritis-like change confined to the pyloric portion of the stomach." Konjetzny and his collaborators have pointed out the constant occurrence (up to 100 per cent) of these gastritic changes and have demonstrated a relationship between them and the fully developed ulcer.

About a century ago gastritis was advanced by Broussais as the alleged cause of most pathological phenomena. These early records are confusing, however, as postmortem digestion and putrefaction were often interpreted as signs of inflammation. Now radical surgical procedures furnish fresh material which can be placed in fixative solutions in the operating room. Heyrowaky in 1913 studied fragments of the gastric wall removed at gastro-enterostomy in cases of ulcer or cancer and in these he found an inflammatory change constantly present. In a review of 40 cases of gastric ulcer Sole found an associated gastritis in every instance. Recently Fitzgerald placed on record 9 cases of chronic follicular gastritis with symptoms or signs suggesting chronic ulcer but with the absence of such findings at operation or in the gross specimen. A long list of similar cases have been reported during the past 10 years and numerous authors (Konjetzny, Faber, Fitzgerald, etc.) now recognize chronic follicular gastritis as a clinical and pathological entity.

Chronic gastritis may be defined as an

infiltration into the stomach wall chiefly the mucosa of chronic inflammatory cells. In about 50 per cent of the cases (6) there is a pronounced hyperplasia of the lymphoid tissue (follicular apparatus) and in this instance the lesion is referred to as chronic follicular gastritis.

The present study embraces material removed from the stomach wall in an almost consecutive series of 56 cases of gastric resection in this hospital over a recent period of several months. The resections varied greatly in extent in several instances the major portion of the organ being included. The tissue was placed in a fixative solution as soon as possible. Our first problem was to establish what might be considered a normal organ and for this purpose stomachs from an unpicked series of 24 autopsies were examined, discarding only those which showed considerable evidence of postmortem change. Numerous sections were taken for microscopic study from representative areas and in studying the surgical specimens sections were taken from the same relative areas, as far as possible, in order to facilitate comparisons.

The normal mucous membrane has a greyish pink color and in the empty stomach forms numerous high, longitudinal folds, the rugae. The surface epithelium covers the free surface of the mucosa and dips down into the necks of the gastric glands. It begins abruptly at the cardia and is replaced by intestinal epithelium at the pylorus. It has the same structure in all parts of the stomach—a tall simple columnar epithelium with cells filled with mucigen granules which furnish the layer of alkaline mucus for lubrication of the mucosa.

Beneath the surface epithelium is the lamina, or tunica propria, a loose connective tissue framework which supports the glands. This delicate network forms larger accumulations between the neck of the glands and contains a varying number of cells. Besides oval, pale nuclei which seem to belong to fibroblasts or reticular cells the meshes contain



Fig. 1 Chronic follicular gastritis, duodenal ulcer. The glands are separated by the extensive chronic inflammatory infiltration. One large lymph follicle with hyperplastic germinal center.



Fig. 2 Chronic gastritis, adenocarcinoma. Extensive lymphocytic infiltration in the depths of the mucosa with thickening and infiltration of the muscularis mucosae.

frequent free elements mostly lymphocytes, but also a few plasma cells and eosinophiles. In the deeper portions of this lamina small spherical accumulations of lymphoid tissue occur normally. These are more numerous at the pyloric and also the cardiac end. In the autopsy stomachs studied we found these lymphoid follicles were relatively few in number and in about 30 per cent of cases were not found at all. In a very small number their germinal centers were hyperplastic.

The glands of the stomach are of three types. The cardiac glands form a narrow ring about the cardia, are similar to those found in the oesophagus and at present, while their function is unknown, they are probably merely mucus producing glands. The pyloric glands occupy the pyloric region and are lined by cuboidal cells similar to those found in the cardiac glands or the necks of the fundic glands. These cells are mucus secreting. The gastric glands proper, or fundic glands, occupy the fundus and proximal two-thirds of the stomach. These are the most important glands; they are closely arranged and penetrate the whole thickness of the mucosa. They are composed of first the chief or zymogenic cells which are pyramidal cells with a spherical nucleus. These are found in the lower half of the gland and contain granules believed

to be pepsinogen. The parietal cells are slightly triangular cells which lie between the chief cells and the basement membrane and are more numerous toward the neck of the gland. These stain deeply with eosin and are believed to secrete hydrochloric acid or its precursor. The necks of the glands are lined by mucus secreting cells similar to the surface epithelium. These cells then are responsible for the secretion of the gastric juice and are aided by the pyloric glands which also secrete some pepsin, alkaline in reaction.

The line of demarcation between the fundic and pyloric gland areas is less well defined in the human stomach than in that of the dog. An interesting observation is that this border line extends much higher along the lesser curvature (above incisura angularis) than it does along the greater curvature.

In the series of 24 autopsy stomachs, 20 could be classed as normal, 2 were believed to show slight evidence of chronic gastritis while the 2 remaining were rejected because of postmortem degeneration in the 1 case while the other was complicated by carcinomatous invasion from the pancreas. These specimens were chiefly from individuals of middle age or upward, yet could be classed as essentially normal in over 90 per cent of cases. In our series of 56 surgical stomachs chronic



Fig. 3 Chronic follicular gastritis, multiple chronic ulcers, gastric and duodenal. Widespread infiltration of chronic inflammatory cells. Glands active with layer of mucus on surface. One hyperplastic lymph follicle.

follicular gastritis was diagnosed in 37 or 66 per cent while chronic gastritis was found in 18 cases, or 32 per cent. The remaining case was normal, the operation performed was gastrotomy for feeding purposes in a patient suffering from carcinoma of the larynx.

Stomachs, the site of chronic follicular gastritis, show definite pathological changes the microscopic picture being most striking. In the gross the most constant finding (2) is a thickening and palpable stiffening of the stomach wall in the pyloric region. Perigastric adhesions may unite the stomach to neighboring tissues, and enlarged soft reddish lymph glands are found above and below the pylorus in about 50 per cent of cases. On opening the stomach the mucosa of the pyloric portion is a deeper pink color than usual and is covered by a thick layer of sticky mucus. The mucosal folds are often smoothed out and tiny ulcerations or erosions may be present frequently made more conspicuous by a surrounding elevation of mucosa. Occasionally the mucous membrane shows areas of atrophy or papillary overgrowth.

Microscopically the mucosa shows the most marked changes and in mild cases is the only layer of the gastric wall affected. The reaction is predominantly chronic and is localized to the pyloric gland region stopping

rather abruptly in the transitional zone between the pyloric and fundic gland areas. In cases of ulceration in the fundic gland region the adjoining fundic mucosa, chiefly along the lesser curvature is involved in the inflammatory change which extends throughout the pyloric area as well. The tubules of the gastric glands are separated by numerous chronic inflammatory cells which prove to be chiefly plasma cells in the more superficial portions between the necks of the glands and lymphocytes with varying numbers of eosinophiles in the deeper portions of the mucosa. In about half the cases (6) a marked hyperplasia of the lymphoid tissue (follicular apparatus) is found in the base of the mucous membrane which may be aggregated into lymph follicles having hyperplastic germinal centers or extend as a continuous layer of lymphoid tissue resting on the muscularis mucosae. Ragnotti (5) found such lymphatic formations in 26 of 33 cases of gastric and duodenal ulcer. The lymph follicles are round or oval in shape and vary in size frequently occupying more than half the thickness of the mucosa. The presence of numbers of these follicles warrants the diagnosis chronic follicular gastritis. The cells of the gastric glands show surprisingly little change though the glands often undergo atrophy when the cellular infiltration is pronounced. The cells lining the free surface of the mucosa and the necks of the gastric glands are usually very active and distended with mucus, a layer of which frequently bathes the surface of the mucous membrane. Small superficial erosions and tiny ulcers are not infrequent. Areas of local overgrowth of the mucous membrane are sometimes found and in advanced cases atrophy of the mucosa with cyst formation. In a small number of cases an acute process accompanies the chronic reaction with the latter usually predominating. As a rule, polymorphonuclear infiltration is confined to the superficial and mild portions of the mucosa, often in relation to small acute ulcers.

The muscularis mucosae is invariably thickened except in mild cases. It is frequently split into layers which are separated by the same type of chronic inflammatory cells. The



Fig. 4. Chronic follicular gastritis, near gastric ulcer, small. Two large hyperplastic lymph follicles. Edge of ulcer seen at right.



Fig. 5. Chronic gastritis, chronic ulcer and small adenocarcinoma. Early erosion in mucous membrane, leading down to small lymph follicle.

inflammatory reaction commonly spreads into the submucosa but is much less pronounced although lymphoid aggregations also occur. Islands of lymphocytes and eosinophiles are occasionally found in the muscle layer and subserosa usually about a small blood vessel. The blood vessels in the submucosa and subserosa seem increased in number and are often distended. Frequently the inflammatory process is not limited by the pyloric ring but extends a variable distance into the duodenum.

In our series of 37 cases diagnosed chronic follicular gastritis it was associated with duodenal ulcer on 18 occasions with gastric ulcer on 8 gastric cancer on 3 and with stomal or jejunal ulcers in 4 cases. In 4 the condition existed alone. In 1 of these (Case 46) duodenal ulcer had been diagnosed and confirmed by X ray but at operation no ulcer was found while the pylorus was indurated. A second (Case 67) was diagnosed clinically as carcinoma of the pylorus with a filling defect on X ray though operation revealed neither cancer nor ulcer. A third (Case 68) was also diagnosed duodenal ulcer prior to operation with doubtful X ray findings but in view of the patient's great pain operation was undertaken and no ulcer found. The fourth (Case 70) had a history suggesting

duodenal ulcer for 3 years but X ray revealed only a polyposis of the duodenum and no ulcer was found at the subsequent operation or in the pathological specimen submitted.

Of the 18 cases diagnosed in microscopic section as chronic gastritis, duodenal ulcer was associated in 7 gastric ulcer in 4, gastric cancer in 3 and stomal ulcer once. The condition existed alone in 3 cases. In 1 of these (Case 39) the gastritis was very slight the patient having swallowed a pin some 10 days previously which was recovered at operation. Another (Case 62) had been diagnosed as gastric ulcer by X ray 6 weeks prior to operation but no such lesion could be found. The third (Case 29) was associated with duodenal ileus. In this case there was a doubtful X ray diagnosis of minute ulcer of pylorus some 6 years previously.

Summarizing in 56 surgical stomachs chronic inflammatory changes were found in the wall of all cases except one and in 37 of these lymphoid hyperplasia was a prominent feature. By comparison with the normal stomachs obtained at autopsy, these surgical specimens showed a definite chronic inflammatory change well localized to the pyloric region of the organ. Ringertz interprets this limitation to the pyloric region as the expres-

sion of a special reaction of the mucous membrane in this region to a chronic peptic irritation. In about two-thirds of the present series of cases the gastritis was associated with either duodenal or gastric ulcer chiefly the former. Most of the remainder were associated with stomal ulcer or gastric cancer. In all of our cases of carcinoma ulceration was present also and in two instances the cancer appeared to be arising in a former chronic ulcer. In 40 cases of gastric ulcer Sole found an associated gastritis in every one.

The conclusion seems justifiable that chronic gastritis is a definite pathological lesion almost constantly associated with peptic ulcer, gastric cancer or stomal ulcer. In the present series 7 cases showed a chronic inflammatory change in the absence of ulceration. Of these 4 were diagnosed chronic follicular gastritis and had been considered clinically as duodenal ulcer in 3 cases and carcinoma of the pylorus in the fourth. In the 3 cases of chronic gastritis where no ulcer was found one had

been diagnosed by X-ray gastric ulcer while the 2 remaining cases had a more or less obvious cause for the gastritis. In view of these findings, I believe one must accept that chronic follicular gastritis may exist as a definite entity in the absence of ulceration. This belief is shared by a number of writers (Faber, Fitzgerald and others). The etiology of the gastritis and its exact relationship to peptic ulcer whether it be a primary lesion or merely secondary to the ulceration has not yet been definitely established. I am inclined to view the gastritis as a primary lesion and believe that therein lies a fertile field for seeking the origin of the chronic peptic ulcer.

REFERENCES

1. FABER, K. *Lancet*, 1927 II, 901-907.
2. FITZGERALD, R. M. *Brit. J. Surg.* 1931 xiv, 25-26.
3. KOWJERTY, G. E. Quoted by Lindau and Wolff.
4. LINDAU, A. and WOLFF, H. *Surg. Gynec. & Obst.*, 1931 lxi, 62-63.
5. RAGGIOU, E. *Centralbl. f. Path.* 1932, lv, 58-59.
6. RINGHEITZ, N. *Acta path. et microb. acad.* 1931 viii, 383-387.
7. SOLE, R. *J. Internat. Abstr. Surg.* 1931 lxi, 546.

IV, BLOODLOOD

# CLINICAL SURGERY

FROM THE UNIVERSITY OF OREGON MEDICAL SCHOOL

## SEVERING ADHESIONS IN ARTIFICIAL PNEUMOTHORAX BY THE ELECTROSURGICAL METHOD<sup>1</sup>

RALPH C. MATSON, M.D., F.A.C.P., F.A.C.S., PORTLAND, OREGON

PROCEDURES for establishing functional rest of the lung and closure of cavities through lung collapse or compression represent a very distinct advance in the treatment of pulmonary tuberculosis. Of the various methods of collapse therapy artificial pneumothorax is the most valuable, most widely applicable and most extensively employed. It is deplorable that its application is restricted to less than half the cases wherein it is indicated because of pleuritic adhesions allowing either no collapse of the lung at all or insufficient collapse to provide adequate rest or closure of cavities. An ineffective pneumothorax caused by pleuritic adhesions is a common experience to all who employ artificial pneumothorax in the treatment of pulmonary tuberculosis and the greatest indictment against the method, no doubt, is the persistence with which an ineffective pneumothorax is continued month in and month out (sometimes for years) when clinical and roentgenological evidence clearly shows an unsatisfactorily collapsed lung still a source of tubercle bacilli-laden sputum, fairly constant in its quantity because of an open cavity. In such cases sooner or later the disease extends to the opposite lung, intestines or larynx. The case is often then too far advanced for other surgical collapse measures and the patient is destined to chronic invalidism, facing a certain doom.

According to our experience in over 1,500 cases of pulmonary tuberculosis treated by artificial pneumothorax 40 per cent of failures in pneumothorax therapy have been caused by pleuritic adhesions which prevented a satisfactory collapse of the lung.

As a result of our observations, we are convinced of the importance of establishing a type of pneumothorax which, within 4 to 6 months, will give the diseased lung sufficient functional rest, collapse, or compression to render it no longer a source of tubercle bacilli-laden sputum or tuberculoxemia.

Stretching adhesions in an effort to secure a satisfactory lung collapse by gradually increasing the intrathoracic pressure is seldom successful (except when minor adhesions are present) and may precipitate a tear resulting in spontaneous pneumothorax and empyema. Opening the pleural cavity to cut adhesions is tolerated poorly by tuberculous patients and the results do not justify the procedure.

If severing adhesions by surgical methods comes into question undoubtedly the much neglected method of closed intrapleural pneumolysis is the procedure of choice. In selecting the closed method of approach we have for consideration the method proposed by Jacobaeus in 1913 utilizing the galvanocautery for cutting purposes or instead of the galvanocautery, the electrosurgical method utilizing a high frequency current, may be used according to the author's technique (7, 8).

The cauterization of adhesions by the galvanocautery is objectionable because of the heat, smoke, pain and reaction following operation. Perhaps its greatest shortcoming is the character of the cutting produced as tissue is destroyed a short distance around the cautery; thus, blood vessels are severed without any previous obliteration unless a dull red heat is used (dark room control) and undue bleeding may occur. In addition to the danger of bleeding if too much heat is employed there is also the possibility of tissue necrosis occurring which may involve the parenchyma of the lung, tuberculous cavities or tuberculous foci resulting in spontaneous pneumothorax and empyema.

Because of the obvious objections to the galvanocautery and the success of electrosurgery, especially in brain and cancer surgery, it seemed very probable that this method could be applied intrathoracically with advantage. Several years ago, we began studies of this method which necessitated the development of technique and instru-

<sup>1</sup>From the Department of Thoracic Surgery, Portland Open Air Sanatorium, Milwaukie, Oregon, and the Department of Medicine, University of Oregon Medical School.



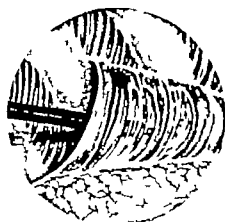


Fig. 1. Arachnoid adhesion showing electrode passed through its meshes. It never contains lung tissue nor blood vessels.

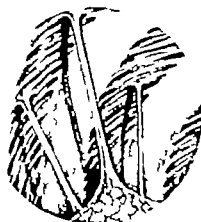


Fig. 2. Three string adhesions of various sizes extending between the partially collapsed lung and chest wall. This type never contains lung tissue nor blood vessels.

ments which now after 4 years application, are sufficiently perfected and tested to offer as superior to galvanocautery instruments and method.

In adapting the electrosurgical method of closed intrapleural pneumolysis, the disadvantages of the galvanocautery have been eliminated, and many definite advantages achieved by the use of this more modern and adaptable cutting method.

The indications, contra indications, and selection of cases for operation have been fully discussed in the author's previous communications.

#### PLEURITIC ADHESIONS

Before discussing the operative technique, a brief description of adhesions commonly met with at operation will be given but no attempt will be made in this compilation to discuss their origin.

A. *Arachnoid adhesions* (Fig. 1) These, when recent, separate readily without cutting. They never contain lung tissue and are not of technical importance.

B. *String adhesions* (Fig. 2) These are usually round but sometimes flat some are elastic and fragile while others are vascular. As a rule, only a slight increase is seen in their diameter at the chest wall and lung attachments. They are of little clinical importance except when numerous and fibrous.

C. *Cord adhesions* (Fig. 3) This form has the same characteristics as the former group only they are larger, and while essentially round, at times show ridging. The thoracic wall and lung attachments are often slightly broadened, especially when short, and might be then mistaken for spool or capstan adhesions. They are seldom highly vascular but are of technical importance as a

satisfactory collapse of the lung is often prevented by a single cord adhesion.

D. *Band adhesions* (Fig. 4) These vary greatly in their length, thickness, and breadth. They rarely contain lung tissue but sometimes blood channels of considerable importance are encountered. This type is of great technical importance. Aside from bleeding severance which should be made close to the chest wall is not associated with danger.

E. *Fan shaped adhesions* (Fig. 5) In this form, small blood vessels are often contained in the free edge. The transition between lung tissue and adhesion is clearly defined. They rarely contain lung tissue and should be severed near the lung attachment. Cutting is not dangerous and a good therapeutic result follows.

F. *Funnel or cone shaped adhesions* (Fig. 6) This type commonly occurs over superficial cavities, in which case the cavity is often projected into the adhesion. Cutting them, unless around the chest wall attachment, is dangerous.

G. *Spool or capstan adhesions* (Fig. 7) These contain blood channels of marked importance, also prolongations of cavities. The pulmonary half always contains lung tissue. Although they are less dangerous to cut than the funnel type, they often present the same hazards and should be severed near the chest wall.

H. *Fold and curtain adhesions* (Fig. 8) While frequently appearing as bands on stereoscopic films, giving the impression of being easily cut, they are mostly non-operable except when thin.

I. *Diffuse adhesions* (Fig. 9) In this type, the lung is densely adherent to the chest wall. They are responsible for more failures in pneumothorax

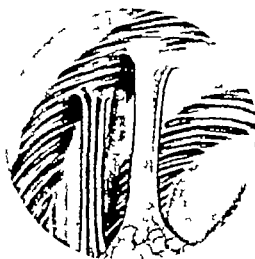


Fig 3 Cord adhesions. The somewhat triangular and round type of cord adhesions are shown. Neither contain lung tissue nor blood vessels, but should be severed close to the chest wall instead of in the middle.

than any other kinds of adhesions, and are seldom suitable for cutting

#### THE ELECTROSURGICAL METHOD (AUTHOR'S METHOD)

A detailed description of the physical characteristics of electrical currents employed in electro-surgery will not be given here, as the subject has been well covered by Ward, Clark, and Cushing. However, for the purpose of cutting pleuritic adhesions by the closed method when haemostasis by the usual surgical procedure is denied a brief description of the intrathoracic application is justified.

The cutting effected by the electrosurgical method is not a true cutting but a molecular disintegration of tissue produced by a high frequency undamped current—an arc being formed at the point of contact between the tip of the electrode and the tissue. By this method blood and lymph vessels are sealed, no bleeding occurs and danger of liberating infection from the cut adhesion is infinitely less. There is no radiating heat, no smoke to disturb the view, less pain and only a very mild reaction after operation.

Intrathoracically 3 types of current are used to accomplish first superficial dehydration second coagulation and third cutting.

Superficial dehydration is seldom used as the cutting current delivered by the Bovie Unit<sup>1</sup> has sufficient dehydrating properties to prevent bleeding in severing adhesions containing small blood vessels (up to 2 or 3 mm.)

<sup>1</sup>Manufactured by the Lidel-Fleming Company, Cincinnati, Ohio. For the past three years, we have used the Bovie Unit exclusively and found it ideal. Recently we have used the Bovie Rose Unit and found it satisfactory.



Fig 4. Two types of band adhesions. They may contain blood vessels but rarely lung tissue, and should be cut at the chest wall attachment.

Coagulation is widely employed as a preliminary preparation to the cutting of all adhesions containing or suspected of containing blood vessels of a moderate size. Coagulation of vascular tissue is the best preparation for cutting which may be done immediately after coagulation, or at times better left to future operations if large blood vessels are seen. Often safe spontaneous separation or stretching may take place obviating the necessity of a later cutting operation. In an old pneumothorax with a thickened pleura, it is frequently difficult to come to a conclusion regarding the nature of the tissue to be cut. Our procedure in this type of case is to surround the chest wall attachment of the adhesion with a path of electro-coagulation (Fig 10). After the chest wall has been sealed (24 to 48 hours) reinflations are energetically pursued and in a short time the coagulated area usually separates, or the adhesion will be seen to stretch out into a slender cord (Figs 11 and 12).

**Cutting.** The form best adapted for intrathoracic purposes is a current of extreme high frequency with a wave form known as moderately damped. While the degree of dehydration depends to some extent on the cutting surface of the operating electrode (which is quite blunt) and the amount of power, depth and speed at which the instrument is moved, it depends chiefly on the character of the current or wave form—this may be varied to suit the type of tissue being severed. The greater the blood supply the greater the degree of dehydration or coagulation that must be used.

#### PRE-OPERATIVE PREPARATION OF THE PATIENT

The patient is prepared as for a major thoracic operation. Serous exudate except when present only in very small quantities, ought to be aspirated a few days before operation, and a pneumothorax refill given at this time (if necessary) to provide as large as possible a pneumothorax in which to



Fig. 5. View of a fan shaped adhesion with base attached to the ribs and intercostal muscles, and rounded apex attached to the lung. Lung tissue is rarely present but may contain blood vessels of considerable size. Should be cut adjacent to the lung attachment.

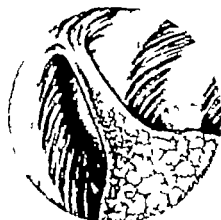


Fig. 6. Funnel or cone shaped adhesion. This type contains lung tissue and often the prolongations of a cavity and blood vessels should be cut at the chest wall attachment, if operable. Otherwise, this type of adhesion may be electrocoagulated.

work. If the pleural cavity contains a purulent exudate, it should be washed out with salt solution before operation. In the event of a febrile reaction occurring following aspiration, it is best to postpone the operation until no such reaction follows. If the patient is apprehensive, a mild sedative may be given the night before operation to insure a good sleep and sputum drainage should be carried out in the morning before operation, so as to prevent excessive coughing during and immediately after operation. Immediately before operation an injection of pantopon or morphine is usually advisable.

#### THORACOSCOPY

Undoubtedly the most valuable method of determining the possibility of severing adhesions is by thoracoscopic examination of the pneumothorax cavity. The possibility of operation and the degree of success or failure can be determined in many cases, only by this method, therefore it should be utilized in any doubtful case as it is harmless.

The instruments (Fig. 13) required for thoracoscopy are preferably an Unverricht thoracoscope<sup>1</sup> with transformer to control its illumination, and a trocar and bakelite cannula<sup>2</sup> by means of which the thoracoscope is introduced through the thoracic wall. After working with numerous thoracosopes, both direct and indirect, as well as operating thoracosopes, we believe the Unverricht thoracoscope is the best for general use.

*Author's trocar and cannula.* The trocar is adjustable to the different lengths of the cannulas. Three different lengths of cannulas are available for use, according to the thickness of the chest wall. The cannulas, of a size to fit the thoracoscope, are made of bakelite preventing short circuiting of the high frequency current to the chest wall when used with the operating electrodes.

The position of the patient on the table depends upon the operative approach. In most instances, the pneumothorax side will be up (Fig. 14) as most adhesions will be found in the posterior upper quadrant of the pneumothorax cavity. However the point of entrance of the thoracoscope will depend entirely upon careful study of the stereoscopic films.

We prefer the posterior approach, not only because most adhesions can be more accurately and conveniently studied from here but also because the intercostal vessels, at this point lie in the rib sulcus, and are well protected from injury during introduction of the trocar and cannula for the thoracoscope. The anterior approach for the thoracoscope is never used by us except in the case of apical adhesions anteriorly located.

Local anesthesia for the introduction of the thoracoscope is similar to that for a pneumothorax refill. Caution must be exercised in approaching the pleura, lest the lung be close to the chest wall and punctured. Careful infiltration of the endothoracic fascia is essential. The intercostal space being used is injected with 10 cubic centimeters of 1 per cent novocain suprarenalin solution, but there is no need to anesthetize the intercostal spaces above and below the site of puncture.

<sup>1</sup>Manufactured by Carl Zeiss, 435 Fifth Ave. New York, N. Y.

<sup>2</sup>Manufactured by Carl McKelch, 401 S. E. 6th Ave. Portland, Oregon.

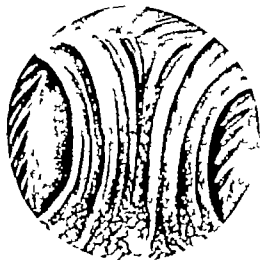


Fig. 7. Spool shaped adhesion containing compressed lung tissue and blood vessels. This type of adhesion should not be cut at its narrowest part but at its chest wall attachment, if at all. This type is ideal for electrocoagulation.



Fig. 8. Fold or curtain adhesion. Arises from an interlobar pleuritis. May contain lung tissue and blood vessels. Should be severed (if at all) at the chest wall by transillumination.

It is necessary to make sure that the lung by chance, is not adherent to the chest wall, or that an adhesion not shown on the roentgen film is not attached at the point of entrance selected for the thoracoscope. Also it is important to know whether the lung if not adherent, is far enough away from the chest wall or if an adhesion is present that it is sufficiently distant to permit manipulation of the thoracoscope. These difficulties are amplified by a preliminary sounding of the pneumothorax cavity with a Solomon catheter through a small cannula introduced through a puncture at the site selected for the thoracoscope (Fig. 15). Next a 1 centimeter incision is made through the skin and the trocar and bakelite cannula<sup>1</sup> for the thoracoscope are gently pushed through the chest wall in a horizontal direction. The outer end is depressed and the tip of the instrument directed upward, thus avoiding the trickling of blood down the shaft of the cannula, which might later foul the lens. Care must be taken to avoid suddenly plunging the trocar through a thickened pleura that offers considerable resistance.

The room is then darkened the trocar withdrawn from the cannula, and the thoracoscope introduced in a horizontal direction with the lens up. A general survey of the pneumothorax cavity is made followed by a careful study of the adhesions which should furnish complete orientation regarding their position and direction with relation to the chest wall and collapsed lung as well

as their dimensions configuration and type. It is particularly essential to know how close the point selected for cutting is to large blood vessels or important nerve trunks. The presence of lung tissue blood vessels, and tuberculous deposits in the adhesions to be cut should be determined, following this a study is made of the inner chest wall, and a site selected for entrance of the operating electrode—one that will give an unobstructed view and permit placing the cutting instrument in the most advantageous position across all important adhesions at a proper angle for the purpose of cutting and avoid introducing the electrode at a point where adhesions prevent its being seen as for instance on the blind side of adhesions.



Fig. 9. Diffuse adhesion. The parietal and visceral pleura are intimately fused; lung tissue extends to the chest wall blood vessels are abundant. Complete severance should not be attempted.

<sup>1</sup>The author uses a bakelite cannula for the thoracoscope instead of the Uvrich ball-valve type because it permits an interchange of instruments; moreover the ball-valve cannula is unnecessary as the intrathoracic pressure is equalized the moment the cannula for the operating instrument is introduced.



Fig. 10 Deep puncture coagulation of the chest wall. Attachment of a spool adhesion, showing electrode and line of coagulation. Insert, Pointed operating tip penetrating the chest wall attachment for deep coagulation.

#### ELECTROSURGICAL CUTTING

The instruments required for the electrosurgical method of cutting adhesions, aside from the electrosurgical unit are the operating electrodes, extensions and operating tips for the electrodes (Figs. 16 and 17). These instruments and their manipulation have been fully described previously. (8) and full instructions are furnished by the manufacturer.

The point of entrance of the electrode will depend entirely upon the thoracoscopic findings. Since in the majority of cases, the thoracoscope will be most advantageously introduced at the angle of the scapula, the anterior axillary line will prove a very suitable place for introducing the electrode—the intercostal spaces being wide and permitting a greater degree of manipulation of the instrument. Furthermore, the relative position of the two instruments is very satisfactory. The area to be entered on the chest wall is controlled by making gentle pressure upon the intercostal space with the index finger of the free hand on the external surface—one then observes the result through the thoracoscope. If accurately located the operator will observe unless the pleura is very thick, a circumscribed bulging of the intercostal

space as downward pressure is exerted by the finger (Fig. 18).

After suitable infiltration of the site determined upon for introduction of the electrode the infiltrating needle is passed into the pneumothorax cavity and observed through the thoracoscope. The needle is then withdrawn sufficiently to allow careful infiltration of the pleura and endothoracic fascia. This area may be observed through the thoracoscope as a blanched one. Through a small skin incision the trocar and cannula for the operating electrode are introduced in the same manner as that of the thoracoscope. Here however the maneuver is controlled by the thoracoscope.

After inserting the cannula for the thoracoscope, as described the electrode is introduced and placed upon the adhesion. Decision as to the point where the adhesion is best cut will depend upon its type and its relationship to important structures.

In proceeding to sever the adhesion, one should bear in mind that the closer the cutting is to the chest wall, the greater will be the pain and danger of bleeding, inasmuch as sensation comes from the intercostal nerves, and the blood supply of adhesions is derived mostly collateral, from the intercostal vessels. On the other hand, division near the lung while painless, is dangerous, because one may open into a prolongation of a cavity projected within the adhesion or into compressed lung tissue and, in either event, precipitate a spontaneous pneumothorax or liberate infection—almost certain to result in empyema.

The beginner will do well to confine himself to string cord and small band adhesions, the spool, funnel, and certain types should be avoided. It must be a fixed rule never to cut any tissue until the operator is perfectly familiar with its structure.

TABLE 1\*—COMPLICATIONS AFTER OPERATION INCLUDING THE GALVANOCAUTERY AND AUTHOR'S METHOD—249 CASES

	%	Per Cent
Serous exudate	63	25.7
Purulent exudate	4	1.6
Hemorrhagic exudate	26	10.4
Febrile reaction	7	2.8
Severe hemorrhage	3	1.2
Brochopleural fistula	4	1.6
Spontaneous pneumothorax		4
Severe postoperative vomiting		4
Gas embolism	0	
Shock	0	
Severe surgical emphysema	0	

\*This table comprises complications occurring in 24 patients operated upon with the galvanocautery and 3 operated upon by the author's method. However, in 21 of the latter group an electrode in high frequency operation was used, while in 24 cases the fluoroscope was employed.



Fig. 11 (retouched) Cone shaped adhesion preventing collapse of a cavity 2 which is prolonged into the adhesion. 1, Shows the chest wall attachment after electrocoagulation. The configuration and size of this cavity had remained unaltered by a pneumothorax in the previous 3 months.

After the adhesion has been completely cut through a careful examination is made for bleeding which must be arrested by application of the coagulation current. If bleeding has taken place the pleural cavity should be washed clean with salt solution.

The operator having satisfied himself that everything is in order within the pneumothorax cavity, the instruments are withdrawn and the incision closed with a single gut suture.

The patient is emphatically warned against coughing. A small roll of one inch gauze bandage

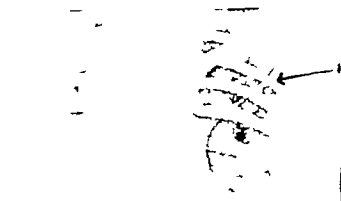


Fig. 12 (retouched) The same case 1 month later. The cavity is completely closed.

for compression is held firmly over the site of the puncture and this is covered with strips of three inch adhesive plaster, extending well to the front and back.

#### POSTOPERATIVE CARE

The postoperative care consists in absolute bed rest, with the side operated upon up for the first 24 hours. Cough should be controlled during the first 24 to 48 hours with codeine, dionine, or even morphine if necessary. Bed rest is maintained for a minimum of 7 days. Straining at stool and physical efforts including excessive laughter are prohibited.

The strictness and duration of the postoperative care before the case reverts to the medical service for continuance of pneumothorax treatment depends upon the character of the operation and the patient's reaction. As a rule the postoperative course, following electrosurgical cutting is mild at times a temperature of 99 to 100 degrees F may last but a few days. Postoperative pain, if any is slight and easily controlled with codeine.

After 24 to 48 hours a roentgen film should be made, and the time and quantity of gas re-inflation decided upon. The intrapleural pressure usually will be less than before operation. Positive pressures must be avoided when possible but should thick walled cavities be present with thickened pleura it may be necessary to resort to positive

TABLE II—COMPARATIVE FREQUENCY OF EXUDATE FORMATION FOLLOWING VARIOUS OPERATIVE METHODS—249 CASES

	Jacobson's method		Author's method			
	Galvanocautery 136 cases		Uncauterized high frequency unit 33 cases		Bovie high frequency unit 78 cases	
	N	Per cent	N	Per cent	N	Per cent
Serous exudate	8	5.9	1	3.0	5	6.4
Purulent exudate	15	10.3	4	12.1	4	5.1
Hemorrhagic exudate	14	10.3	3	9.1	1	1.3

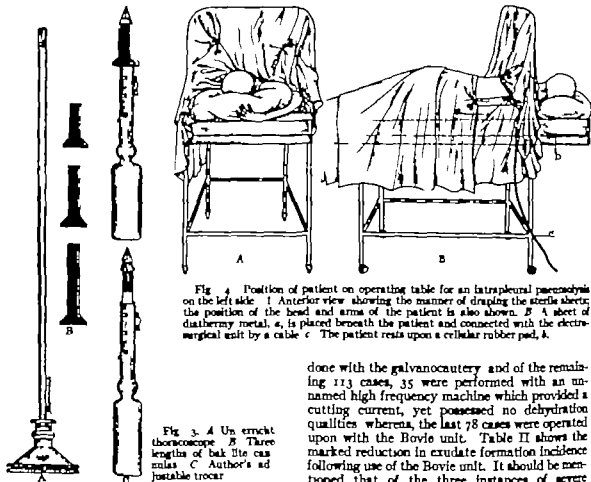


Fig. 4. Position of patient on operating table for an intrapleural pneumolysis on the left side. *A* Anterior view showing the manner of draping the sterile sheet; the position of the head and arms of the patient is also shown. *B* A sheet of diathermy metal, *a*, is placed beneath the patient and connected with the electro-surgical unit by a cable *c*. The patient rests upon a cellular rubber pad, *A*.

Fig. 3. *A* Un-erect thoracoscope. *B* Three lengths of bakelite cannulas. *C* Author's adjustable trocar.

pressures to secure closure of offending cavities. If cavity drainage is interfered with, and sputum retained it may be necessary to aspirate air and slightly expand the lung to establish drainage, following which, frequent refills with smaller quantities of sterile air should be carried out until a satisfactory collapse is established and the patient rendered sputum-free. Re-inflation is carefully controlled by the X-rays, and for the first few inflations, a roentgenogram should be made if possible, after every air injection.

Barring complications, the sanatorium patient may be back on the pre-operative routine in 1 to 2 weeks. Ambulant and working patients, admitted for operation, are individualized regarding their routine.

#### COMPLICATIONS

The complications after operation in our entire series of 249 cases, are shown in Table I. But it should be pointed out that the first 136 cases were

done with the galvanocautery and of the remaining 113 cases, 35 were performed with an unnamed high frequency machine which provided a cutting current, yet possessed no dehydration qualities whereas, the last 78 cases were operated upon with the Bovie unit. Table II shows the marked reduction in exudate formation incidence following use of the Bovie unit. It should be mentioned that of the three instances of severe hemorrhage, one occurred during use of the galvanocautery and 2 during operation with the unnamed high frequency machine. The single instance of spontaneous pneumothorax occurred on the contralateral side 7 days after operation. It was due to an asthmatic paroxysm and was fatal. This case represents the only fatality in the entire series, directly or indirectly due to operation.

#### RESULTS OF TREATMENT

During the past 7 years, 311 operations have been performed on 249 cases (Table III). In 211 cases, a single operation was done, in 23 cases, 2 and 10 cases had 3 operations, 4 cases had 4 operations, and 3 cases had 5 operations each.

In estimating the value of the operation, it must be borne in mind that the purpose of the operation is to convert a useless, or unsatisfactory, pneumothorax into an efficient one. Accordingly the results of operation have to do primarily with the number of unsatisfactory pneumothorax cases which were converted into satisfactory ones, and

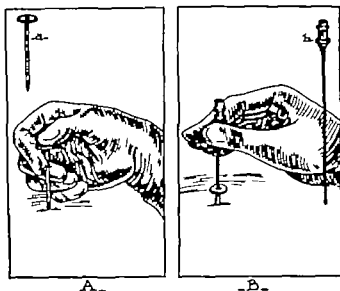


Fig 15 Method of palpating for the lung and nearby adhesions to determine whether site is suitable for introduction of the thoracoscope. A Introducing the cannula, B Introducing the Solomon blunt needle, b

remotely to the end result of the pneumothorax thus established. Every case classified as "clinically and technically successful from the standpoint of the operation, means that complete severance of all adhesions was effected, followed by a satisfactory pneumothorax with prompt (sometimes immediate) disappearance of severe cough and expectoration.

Of the 249 cases, 152, 61 per cent, were technically and clinically successful. Of these 32 cases had to deal only with string and cord adhesions. In 85 cases, band adhesions alone were present in 18 cases only fold adhesions, and in 4 cases, all three types of adhesions were present.

The technically unsuccessful but clinically successful group comprises 19 cases presenting all the above types of adhesions, as well as others described under the classification of adhesions. This group embodied cases wherein some adhesions, because of their character were left uncut, yet sufficient collapse of the lung was obtained to bring about a satisfactory clinical result by electrocoagulation.

It has been pointed out that clinical success is not always dependent upon cutting all adhesions. A determination as to the ones of technical importance should be made and only these severed. Those unimportant technically, if of an unfavorable type for operation, should not be molested. Of the 249 cases forming a basis of this study, 172 70 per cent, obtained a clinically successful result.

The technically successful but clinically unsuccessful cases were two one of these, previously quoted died of a spontaneous pneumothorax 7

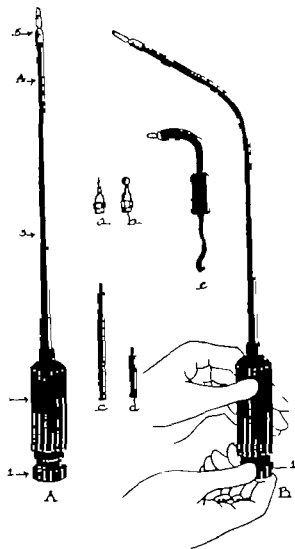


Fig 16 Author's flexible electrode. 1 The instrument straight. 2 Fluted disk for flexing instrument. 3 Hand grip. 4 Hard rubber shaft, except distal one fourth which has a soft rubber covering. 5 Medium shaft extension. 6 Operating tip. B The instrument flexed by turning disk. 7 a, Pointed tip for cutting and deep coagulation. b Coagulating tip. c Long shaft extension. d Short shaft extension. e Connection with unit which fits in the shaft of the hand grip.

days after operation and the other of sudden profuse hemorrhage from the successfully collapsed lung (24 hours after operation) which due to her position, with the pneumothorax side up filled the dependent sound lung. This patient had profuse bleeding from an open cavity before operation the operation was planned to effect closure of the cavity. The technically and clinically unsuccessful group comprises 76 cases 40 of these presented only fold adhesions and 34 had fold adhesions in combination with others of the string cord or band type. These latter were severed but the remaining fold adhesions prevented a satisfactory collapse of the lung



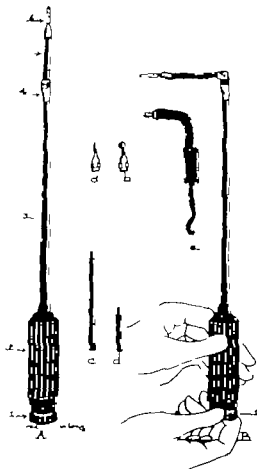


Fig. 7. Author's jointed electrode. A The instrument straight. 1 Disk for angulating the instrument. 2 Hand grip. 3 Hard rubber shaft. 4 Metal joint. 5 Medium extension. 6 Operating tip. B The instrument angulated by turning the disk. 1 2 3 4 5 6 and e the same as in Figure 16.

The remote results, in the cases operated upon, are shown in Table III. Of the 152 technically and clinically successful ones, 120 were bed cases and 32 were ambulant before operation. 146 cases had a positive sputum in 6 it was negative. All these latter 6 were patients who had been under satisfactory pneumothorax but the adhesions were contracting and causing an early lung expansion. These cases had been under observation for 5 years, during which time pneumothorax treatment was continued for at least 3 years. Eight more recent ones are still bed cases. 18 are ambulant, and 126 are working—all have a negative sputum. Of the 10 technically unsuccessful but clinically successful ones, all were bed cases, and all had tubercle bacilli in their sputum. Four

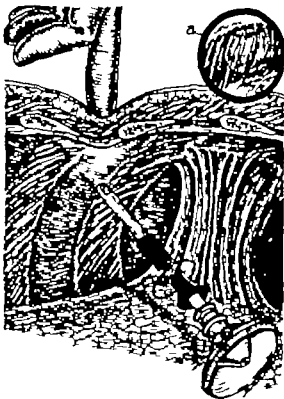


Fig. 18. Method of selecting the site for introducing the operating electrode through the chest wall. a, Thoracoscopic view showing elevation produced by pressure of the finger.

years after operation 7 are ambulant and 12 are working. All have a negative sputum.

#### CONCLUSIONS

It is unjustifiable to continue an unsatisfactory pneumothorax over a prolonged period, because of the danger of extensions of the disease to the opposite lung, to the gastro-intestinal tract or to the larynx. Our experience covering the past 20 years, and including over 1,500 cases of artificial pneumothorax, has demonstrated that intrapleural pneumolysis under thoracoscopic guidance will convert approximately 70 per cent of unsatisfactory cases of pneumothorax into satisfactory ones. We have shown that less than 15 per cent of recoveries take place as the result of the continuation of an unsatisfactory pneumothorax, and that serious dangers attend the use of high intrapleural pressures in an attempt to stretch adhesions. If the adhesions prevent a satisfactory collapse of the lung, after a probation of 4 to 6 months, it is very improbable that a satisfactory end-result will be obtained by further continua-

TABLE III.—INTRAPLEURAL PNEUMOLYSIS REMOTE END-RESULTS OF OPERATION—249 CASES

Result of operation	Cases	Condition before operation				Present condition				Remarks
		Bed	Amb.	Spontane. Pos.	Neg.	Bed	Amb.	Wk.	Spontane. Pos.	
Technically and clinically successful	5	120	32	146	6	8	18	26	151	Working 83 per cent
Technically unsuccessful, clinically successful	10	0		0		7			0	Working 66 per cent
Technically successful, clinically unsuccessful	1	1								Two dead 1 from spontaneous pneumothorax after operation from hemorrhage opposite lung.
Technically and clinically unsuccessful	76	62	14	76		This group comprised cases presenting adhesions unsuited for operation. In most cases minor adhesions of no technical importance were severed. In all appropriate cases patients were subjected to other operative collapse procedures. The end result is not attributable to the pneumolysis—consequently not recorded here.				

\*Wk.—Working.

tion of the pneumothorax. After a trial has been given an unsatisfactory pneumothorax should be converted into a satisfactory one by intrapleural pneumolysis. If this is impractical other surgical collapse methods should be utilized.

The electrosurgical method is superior to the galvanocautery and the operation is not dangerous when properly performed. Our mortality was 1.5 per cent in 249 cases, including the use of both the galvanocautery and the electrosurgical method. This single operative mortality was only indirectly due to the operation.

## BIBLIOGRAPHY

1. CLARK W L. Cancer of the oral cavity jaws and throat. J Am. M. Ass. 1918 lxxi, 1365.
2. Idem. Chapter on Desiccation and Coagulation. Keen's Surgery 8.
3. Idem. Electrothermic methods in treatment of neoplastic and allied diseases. J Am. M. Ass. 1926 lxxvii, 595.
4. CLARK, W L. ARNOLD, E. J. and MORGAN J D. Clinical and histological observations in the treatment of neoplastic diseases by combined methods. Atlantic M J 1923, xxvii 541.
5. Idem. Electrothermic methods in the treatment of neoplastic lesions, etc. Radiology 1924 li, 233.
6. CUSHING, H. and BOVIE, W T. Electro-surgery as an aid to the removal of intracranial tumors. Surg Gynec. & Obst. 1928 xlvii 751.
7. MATSON RALPH C. The cauterization of adhesions in artificial pneumothorax by the Jacobaeus-Unverricht method of closed pneumolysis. Am. Rev Tuberc. 1929 xxx, No. 3.
8. Idem. Operative collapse therapy in the treatment of pulmonary tuberculosis. Western J Surg. 1930 November and December 1931 January.
9. WARD G E. Value of electrothermic methods in the treatment of malignancy. Am. Rev Tuberc. 1925 lxxiv, 660.
10. Idem. The efficient method of hemostasis without suture. Med. J & Rec. 1925 cxxx 470.

are often much more adherent, and when the prostate is incised one much more frequently encounters purulent exudate. The tissues along the cut also show increased redness. (2) If intermittent catheterization is carried out these conditions are found far less frequently. In some instances in which a retention catheter has been used, I have found not only relatively large collections of pus within the prostate itself but in a few cases large quantities of pus collected back of the bladder in the region of the seminal vesicles. Many of the rises in temperature heretofore attributed to renal infection have undoubtedly been due to such infection, but in a number of cases the rises in temperature have been caused by infection of the genital tract. I have seen patients in whom marked arthritis has developed while a catheter has been in place, but the inflammation immediately subsided when the catheter was withdrawn. I have seen patients in whom the absorption has been so great from the retention catheter that the patients ran high temperatures and life itself was in danger. All symptoms subsided when the retention catheter was removed and the patient was intermittently catheterized. I do not subscribe to the idea that infection of the genito-urinary tract is of value in producing a protective immunity; my opinion is that all infection should be avoided as far as possible.

I would now discuss those cases in which the patient has residual urine and needs preliminary treatment. In these cases heretofore either a retention catheter or suprapubic drainage has been used. I shall refer particularly to the cases in which prolonged drainage is not necessary but in which restoration of function is important. In this type of case neither suprapubic drainage nor a retention catheter should be used, provided perineal prostatectomy or resectoscopy is to be done. I will not discuss the value of walling off the suprapubic space where suprapubic prostatectomy is contemplated as my experience does not make me an advocate of suprapubic prostatectomy. These patients should be treated entirely by intermittent catheterization. A retention catheter should not be used for it will surely set up a prostatitis and aggravate a renal infection that may be present or produce one if not present, and this risk is too great for the simple matter of withdrawing urine every 4 hours. It is not necessary to put these patients to bed. They are best treated as ambulatory patients, by competent nurses.

Like many things, intermittent catheterization is easier said than done. Who is going to do it? The internes in our modern hospitals are certainly

too much engaged with their general routine duties to look after the catheterization of even a single patient to say nothing of the varying needs of many cases of prostatic obstruction. It requires considerable skill to catheterize some patients. In my private practice I have solved the problem by having well trained female nurses take care of this work. The nurses are especially trained in the work and they have proved to be a tremendous relief to me and of inestimable benefit and comfort to the patients thus cared for. I am sure that, if he stopped to think, no physician would tolerate having a catheter fastened into the urethra of a patient or subject him to unnecessary suprapubic drainage simply because the interne was too busy; the attending man not at hand, the orderlies inexperienced, and the nurses averse to caring for such patients.

The pre-operative treatment of patients with prostatic obstruction calls for complete reorganization of the routine now practiced in the urological wards. Such reorganization would be of more value to the large free clinic than to private hospitals. Nothing could be more revolting than to see in our public and private institutions men able to be up and walking about the wards who have fastened to them retention catheters reeking with pus. Would it not be far better technique to have taught these patients in the Out Patient Department how catheterization is carried out? They could easily have been made to realize the moderate degree of cleanliness necessary and that such cleanliness far surpasses the use of any type of retention catheter. Furthermore, the patients can remain at home while treatment is being carried out. Of course, there are many indigent patients who require hospitalization because they are totally unable to care for themselves and have no homes. Others come long distances for treatment and must be cared for in the hospital. In such cases the morbidity at present is tremendously increased by suprapubic drainage and retention catheters and the cost to the clinic is much more than would be the cost of a sufficient number of competent nurses to carry out catheterization.

For a number of years it has been my custom to teach certain patients how to care for themselves at home and after office observation for a certain period to operate upon them the day after they are admitted to the hospital. Somewhat similar methods could be carried out at our large public institutions and the saving would be tremendous. I wish to make it clear however that the saving of expense is not the primary reason for my advocating this method. I do believe, however, that the method is associated with higher surgical

idealism. At present patients are confined to bed and subjected to infection and considerable discomfort who could be up and about enjoying life and still have the proper care without being subjected to the measures which are undoubtedly the most trying part of the treatment of prostatic obstruction. When it is necessary that for any reason patients must remain in the hospital—the large private or public hospital—I would suggest that a catheterization station be set up in the hospital and competent nurses on duty constantly night and day be put in charge of this station. The patients should be instructed to report to this station every 2 to 3 hours during the day, according to his surgeon's directions, or at any time when he is uncomfortable. At night catheterization should be carried out at the bedside at intervals best suited to particular cases.

I shall next discuss those cases in which the amount of residual urine is large. It has been suggested that the large amount of residual urine should be gradually withdrawn. With this idea I differ entirely. I have seen no evidence of harm when the entire amount is immediately withdrawn; on the contrary, I have seen the greatest relief, comfort, and benefit follow the withdrawal of the entire amount. When the entire amount of urine is withdrawn, I have found it advisable to instill into the bladder 300 cubic centimeters of 1:500 silver nitrate, to combat infection. The patient should be put immediately on urotropin and his blood pressure and heart action should be watched. If he has been up and around, he should stay up and around and water should be forced. In very sick patients requiring immediate rest in bed, the giving of 500 cubic centimeters of glucose solution intravenously morning and night, with heart stimulants, is of great value. Some of these patients are so saturated with water as to require catheterization at 1 hour intervals. I recall a case in which over a period of 8 hours I withdrew 9000 cubic centimeters of urine in four catheterizations. In this case the patient had been fastened to a gradual decompression apparatus for about 20 hours. He had developed cardiac disturbances and beginning edema of the lungs. This rapidly cleared up upon the immediate complete evacuation of the bladder and by continued evacuations of urine by repeated catheterization of the bladder at short intervals. For this type of case it has been recommended that there be inserted a retention catheter attached to a tube which is raised to such height as will balance the bladder pressure and that the tube be gradually lowered over a fairly long period of time, thus gradually decreasing the urinary pressure. Patients who have such

large amounts of residual urine should certainly not have catheters fastened into the urethra. The question is not entirely a mechanical one but is as well a biological one—the probable infection both of the prostate and of the urinary tract, associated with the retention catheter would far outweigh any benefits that might result from gradual decompression even if this method of treatment were correct, and I do not believe it is. I have at various times done a nephrostomy upon a completely blocked remaining kidney. In no instance have I ever found that the immediate removal of pressure has done anything except the greatest good, and I am sure that immediate bilateral decompression such as takes place following catheterization of the bladder in overdistention is not associated with either renal hemorrhage or anuria. The hematuria encountered is usually due to damaging catheterization and, if anuria occurs, it is due to some other cause than the withdrawal of urine.

As infection is associated with all types of preliminary treatment, it is my opinion that it is valuable to combat the infection from the beginning. I have found that careful catheterization and the use of urinary antiseptics by mouth and the use of instillations of 1:500 silver nitrate into the bladder at each time of catheterization, have been most helpful in combating infection. In some instances it is advisable to start with 1:1000 silver nitrate.

In many instances I believe that suprapubic drainage is advisable in the very ill person whose kidneys have been badly damaged, whose whole system is considerably run down, and who requires drainage over a long period of time. It may be that it will not be possible to build up his kidney efficiency beyond a certain point, say 7 per cent phthalein in 2 hours, but this does not mean that it will not be possible to build up the patient's general resistance so that he will be able to stand a prostatectomy if he has prolonged drainage. In these very ill patients, with high blood nitrogen and low phthalein, after intermittent catheterization over a period of time, I believe that it is a valuable thing to introduce a suprapubic drainage tube and allow these patients to return to their homes for from 3 to 6 months when they should return to the hospital for any type of prostatic surgery that seems advisable. For this type of drainage I have devised a tube which is shown in Figure 1. This apparatus permits the patient himself to adjust the depth of the tube and to remove it for boiling and cleaning. I have found this tube valuable both for suprapubic and for nephrostomy drainage. Pezzer catheters are

difficult to get out, and are therefore not often cleaned. They are apt to break off to collect lime salts, and to harbor infection. The tube which I have devised and have previously described is easily removed without pain, the depth can be adjusted exactly and the patient can sterilize it every day.

#### SUMMARY AND CONCLUSIONS

With the development of resectoscopy and the education of the medical profession in general as to the benign nature of prostatic surgery many patients with prostatic obstruction now present themselves for treatment much earlier than formerly and in many of these patients it is advisable not to carry out any type of preliminary treatment whatsoever in the way of drainage. In those patients requiring preliminary treatment who heretofore have been treated either by retention catheter or by suprapubic drainage the morbidity rate and the mortality rate can be considerably lowered by the routine use of intermittent catheterization. In my opinion there is no justification in this large group of cases for either suprapubic drainage or retention catheter and in this group both of these procedures should be abandoned. If the retention of urine is great, heretofore it has been believed that gradual decompression is advisable. I do not agree with

this. I believe that the fastening in of a retention catheter is a dangerous procedure. I further believe that retained urine should be immediately withdrawn and that immediate stimulation of the kidneys should be carried out, by supportive measures of the heart and, in some instances, by intravenous injections of fluids. I believe that infection associated with the preliminary treatment is a harmful thing and that it should be combated by antiseptics by mouth and by instillations of antiseptics through a catheter. In certain types of cases the patients will better withstand prostatic surgery after intermittent catheterization and suprapubic drainage for a relatively long period of time in spite of the fact that in many instances this treatment does not increase the kidney efficiency or considerably change the blood retention picture. These patients have sufficient renal tissue to carry them along and the prolonged drainage is used only to facilitate the building up of their other body resources.

I have purposely limited this discussion to the particular points which I wish to make and have refrained from discussing the period of drainage which depends upon the condition of the patient, kidney tests, blood retention tests, cardiovascular studies, vasodilatations, and similar subjects about the value of which there can be no question.

## CANCER TREATMENT RESULTS AS SHOWN IN TWELVE YEAR SURVEY AT EVANSTON HOSPITAL

WILLIAM R. PARKES, M.D., F.A.C.S., EVANSTON, ILLINOIS

THE great majority of cancer surveys have been made by surgeons or roentgenologists, covering their observations of the disease as limited to certain organs or systems of the human body. Very few general reports appear in the literature of the last 10 years.

An attempt is made in the following survey to give all of the available interesting facts, including a follow up report, concerning the proved cases of cancer that have been admitted to the Evanston Hospital during the last 12 years.

The Evanston Hospital is a 335 bed general hospital and the survey covers the work of 55 physicians representing nearly every department in medicine these physicians having conducted the treatment in the 453 cases included in the survey. Only cases in which the diagnosis is

proved by microscope or by overwhelming exploratory or clinical evidence are included in this report. The untraced cases are not considered in the treated or percentage columns that appear later in the report. One hundred and sixty-eight additional cases were listed in the record room as cancer cases but were excluded from this report because of lack of proved diagnosis, or because of lack of co-operation on the part of 13 physicians in making a follow-up of their 38 cases. The cases of 6 deceased physicians also were not included because permission was not obtained to follow up their patients.

We feel certain of the diagnosis in 453 cases and were able to get a follow-up report as to the physical condition of 93 per cent of these cases as of February 1, 1933. Failure to get a follow-up

report in but 7 per cent of all the cases of the 55 co-operating physicians seems very gratifying. A much greater failure percentage was expected.

The incidence of cancer is about 1 per cent of all admissions to the hospital during the 12 year period covered in this survey. In order to show the points of interest brought out by the study of these 453 cases, a large chart was made depicting all facts ascertained. The chart however is too large to be printed. Instead we have made from this chart, and directly from the case records 10 tables, endeavoring to show the results of our investigation. The chart is kept for reference in the hospital record room.

Reference to Table I will show that the cases are presented under anatomical classification. Data were accumulated as to age, sex, method of diagnosis—that is whether clinical or by microscope—as to length of time between first symptoms and treatment, heredity, the kind of treatment the present condition of the patient, whether or not there was glandular regional or metastatic involvement, how long since treatment, number of inoperable cases, number receiving palliative treatment, the length of time inoperable cases lived, whether the patients died of other disease without the return of cancer and the number of operative deaths.

The total and percentage columns show that there were 26 per cent male patients and 74 per cent female, that 31 or 7 per cent, of the 453 cases were untraced, that there were 100 inoperable cases that lived an average of but 11 months without treatment from the time first symptoms were noted until death, that 101 received palliative treatment only, that there were 15 operative deaths or over 4 per cent. This operative death mortality is very high, being near the top in a series of such percentages given as from one to five in other hospitals. Inadequate preoperative preparation of patient and overzealous attempts to treat far advanced cases doubtless explains this high mortality.

Hereditary taint was noted in but 38 cases, or 8.3 per cent. This low percentage in my opinion represents lack of knowledge as to the true hereditary history rather than actual facts, and means nothing whatever from a statistical standpoint except to indicate our inability to obtain the real hereditary history in man.

Only 5 or about 4 per cent of the breast cases showed bilateral breast cancer.

The youngest carcinoma case was that of a girl of 12 with pelvic carcinoma. The oldest carcinoma case was that of a woman of 86 whose life was prolonged several years after simple breast

amputation for an ulcerating scirrhus carcinoma. The youngest sarcoma case was in a child of 7 years with sarcoma of the orbit.

The radio knife has been used at this hospital for 3 years only, and then in only 29 carcinoma cases. Those using the radio knife were very favorably impressed with its ease of employment, reduction, and control of hemorrhage, with the satisfactory scars, and with the possibility of prevention of extension of carcinoma. Enough time has not yet elapsed to note the real benefit of its use.

Table II shows the percentage incidence by systems.

Table III gives the general results of treatment as indicated by the follow up returns. It shows that radical treatment was attempted in 80 per cent of cases, that of those treated before 1928 47 per cent lived over 5 years. Of all patients treated before 1928 33 per cent lived over 5 years, the actual average time being 7 years. The total living since treatment is 49 per cent. Six patients who died of other diseases without recurrence of cancer were not included among those living for any certain period.

Table IV shows the number of breast cases in which patients lived under 2 years from 2 to 5 years, and over 5 years, indicating that 47 patients before 1928 had radical treatment of whom 60 per cent lived over 5 years, of the 54 patients receiving any treatment 51.8 per cent lived over 5 years.

Table V gives some details as to the result of different treatments in breast cases, consideration having been given as to whether or not there was glandular, regional, or metastatic involvement. It shows that 74 per cent of the patients having no glandular involvement are living while only 46 per cent of the patients with glandular involvement still live and that none of the patients with metastasis are now living.

Table VI gives a record of results of treatment of pelvic cases expressed in number of years living after treatment, also indicating methods of treatment and respective results, showing that 37 per cent of those treated before 1928 lived over 5 years, that 43 per cent of the 42 receiving radical treatment lived over 5 years.

Tables VII, VIII and IX give the incidence of cancer of cervix, fundus, and adnexa with treatment and results expressed in 5 year cures, and show that 50 per cent of all patients with cervix and fundus cancers having radical treatment lived over 5 years, that but 1 of the 8 adnexa cancer patients survived 5 years after an attempted radical cure.

TABLE I.—CANCER SURVEY—EVANSTON HOSPITAL 1921-1932

Region	Organ or system	Sex		Total number	Distance	Average age	Diagnosis				No. of months onset to treatment	Inoperable	Died of other causes without recurrence	Operative deaths
		M.	F.				Microscopic							
							Pre-operative	Post-operative	Post-mortem	Total microscopic				
Dorsal cavity	Lips			3		5					12			
	Tongue	5		6		59	3			4	12			
	Floor of mouth													
	Pharynx	7	8	5		5	4	10		14				
	Cheek													
Digestive tract	Parotid gland													
	Oesophagus			3		66					8	1	Scalpel yr later	
	Stomach	9	12	23		6		30	10	40	9	9		Shock
	Liver			3						3	9	3		
	Gall bladder	3	7	10		62		8			3	6		
	Pancreas	1	6					3	3	6	9	6		
	Small intestine													
	Appendix		4	2				2		2	6			Peritonitis
	Right colon	5	9	14		50	3	7				4		3
	Left colon			3						3				
54	Sigmoid	8	5	3		57	2	8	1	16	7	0	9	
	Rectum	5	9	14		6	3	9	14			4		
Breast	No glandular involvement		40	40				33		37	3	8		
	Glandular or apical involvement	23	23	7	23	2	17		21	3			Erysipelas	1-40 hrs 1-17 hr Peritonitis
	Melanoma		14	14					3	7	7	3	Peritonitis later	yr
6	Breast	3	3	6			3	3		6	12		Diabetes 9 yrs. later	
Respiratory tract	Larynx												Peritonitis	
	Trachea										3			
	Lungs					3								
	Pleura											6		
Genitourinary tract	External genitalia	5		5		46				5	9			
	Uterus										7			
	Bladder	16		27	6	53				34	3	9	Carcinoma	
	Prostate gland	14		14		67	6	3			16			
	Uretery	2	4	7		6		2		7		3		
8	Ureter		13	15	4	51	14	8	4	26		3	Hypertrophy of gland 3 yrs later Pregnancy fractured hip cerebral hemorrhage	
	Vagina		17	3		50	3	14		17				
	Adnexa		37			51	7	4	2	11	7	10		Shock
	Vulva	10	5	5		4	3	6	2		7		Carcinoma	
	Clitoris			2		48				2				
	Nervous system					4					9			
	Unclassified		1	16				7	6	13		7		
	Total	119	314	453	3		83	120	66	469	Average 3 mos.	60		15
	Percentage	26	74	60	7		9	55	14	80	21	22	3	4

TABLE II.—PERCENTAGE BY SYSTEMS—453 CASES

System	Total cases	Per cent
Buccal cavity	23	5
Digestive tract	50	11
Colon, rectum, and sigmoid	54	12
Breast	122	27
Scia	6	1
Respiratory tract	8	2
Genito-urinary tract	54	12
Perine organs	60	13
Skeletal, muscular, nervous system	90	20
Unclassified	16	3
	453	100

TABLE III.—RESULTS OF TREATMENT—322 CASES

	Cases	Per cent	Per cent 5 year cures	Per cent 10 year cures
Radical treatment—attempt to cure	260	80.8		
Palliative treatment only	62	19.2		
Group I—				
Treatment over 5 years ago	7	66.1		
Living and well	41		24.4	
Living with recurrence	6		3.4	
Dead, having lived 5 years after treatment	10		5	
Total living 5 years after treatment	57		33	
Radical treatment	1			
Total 5 year cures	58		47	
Group II—				
All cases treated over 5 years ago	27			
Radical treatment	32	60.1		
Alive and well 5 to 9 years after treatment	20		5.95	
Alive and recurrence 5 to 9 years after treatment	8		1.06	
Dead, having lived 5 to 9 years after treatment	6		3.18	
Total in 5 year group	34		9.20	
Total living in Groups I and II 5-9 years	91		50	
Group III—				
All cases treated in whole series	32			
Received radical treatment	260	80.7		
Palliative treatment	62	19.3		
Of radical treatment cases				
Lived 5 years or over	42		6.5	
Living—well 5 to 9 years after treatment	31		8	
Living under 5 years with recurrence	6		2.3	
Living 5 to 9 years with recurrence	7		7	
Living 5 years with recurrence	6		3.3	
Living and well under 5 years since treatment	26		3.8	
Total living	128	40	3.8	16
Dead, having lived 5 to 9 years	42			
Dead, having lived under 5 years	20			30.2
Total dead	132	40.8		

Of the 453 cancer cases there were 28 cases of sarcoma included in this survey. Only one of the 28 patients survived 5 years. Had these cases been omitted from the general cancer survey the percentage of 5 year cures would have been increased somewhat.

Table V shows the type of treatment of sarcoma cases with the results.

On the whole this survey gives strong evidence that even in a general hospital with 55 inde-

TABLE IV.—CARCINOMA OF BREAST—122 CASES

	Cases	Percent
Group I treated before 1928	54	
Alive and well, over 5 years	15	28
Alive with recurrence 5 years after treatment	2	3.7
Dead, having lived 5 years	3	5.6
Total	20	37.3
Received radical treatment before 1928	47	
Total lived 5 years	28	60
Group II, treated to 1931	61	
Alive and well, 5 to 9 years after treatment	9	14.8
Alive with recurrence, 5 to 9 years after treatment	2	3.3
Dead, having lived 5 to 9 years after treatment	9	14.8
Total	20	32.9
Alive and well, 10 years after treatment	9	45
Dead, having lived 10 years after treatment	20	100
Total	33	100
Total treated including 1928	105	
Isoperable	13	12.4
Refused treatment	4	3.8
Total	17	
Living, of the 105 treated, over 5 years	20	19
Living of the 105 treated, from 5 to 9 years	24	23
Living, of the 105 treated, under 5 years	0	0
Total	44	42
Dead, as of February 1931	23	22
Isoperable	13	12.4
Refused treatment	4	3.8
Total	27	
Deaths from other causes—not considered in the 105 treated—	152	
Erysipelas	1	
Pneumonia—1 year later	1	

TABLE V.—CARCINOMA BREAST—RESULTS IN 122 CASES

	Alive 5 yrs.	Alive 5-9 yrs.	Dead after 5 yrs.	Dead 10 yrs. Total
Without gland involvement—				
Treated with radium or X-ray only	1	1	1	3
Treated by surgery only	6	10	1	17
Treated by combinations	1	6	3	10
Total without gland involvement	8	17	5	30
Total living—28 or 74 per cent				
With gland or regional involvement—				
Treated with radium or X-ray			2	2
Treated with surgery only	4	1	3	8
Combinations of X-ray, radium, surgery, diathermy	6	7	3	16
Total with gland involvement	10	8	6	24
Total living—42 or 46 per cent				
With metastases—				
Treated with X-ray or radium			3	3
Treated by surgery only			7	7
Combinations of X-ray, radium, surgery, diathermy			3	3
Total with metastases			13	13
None living				4
Total treated	15			
Isoperable	13			
No treatment	4			
Total	19			

pendent physicians administering the treatment their results are very gratifying. Doubtless earlier diagnosis, improved methods as to operative technique especially as to thoroughness of removal of growths, and the adoption of all reasonable therapeutic means at our command, will lead to greater numbers of 5 year or even permanent cures.

The survey shows that surgery combined with some form of irradiation or diathermy gave better



TABLE VI—CANCER OF THE PELVIC ORGANS—RESULTS IN 100 CASES

	Cases	Per cent 5 year cure
Treated before 1918		
Alive and well over 5 years	29	
Alive with recurrence 5 years	6	
Dead, after 5 years		
Total	35	36 7
Radical treatment before 1918	4	4 8
Treated before 1918	30	
Alive and well 5-9 years	4	
Alive with recurrence 5-9 years	13	
Total	7	1
Treated to February 1918	51	
Alive and well to years	3	
Alive with recurrence to years	1	
Dead, under years	30	
Total	48	
Inoperable	6	
Refused treatment		
Total cases	99	
Living—		
Sarcoma cases	6	
Living		
Carcinoma cases	94	51 34
Living	51	

TABLE VII—CANCER OF CERVIX, CARCINOMA 40 SARCOMA, 1 TOTAL, 41

	Cases	Percent
Treated before 1918		
Alive and well	8	
Dead, having lived 5 years		
Alive with recurrence—5 years		
Total lived 5 years	8	43
Total receiving radical treatment	1	30
Treated before 1918	3	
Alive and well to 5 years	1	
Dead, to 5 years after treatment	2	
Total lived 5-5 years	3	99
Total treated to February 1918	38	
Alive under years	3	
Dead under years	14	
Alive with recurrence under years	1	
Total lived less than years	30	5 6
Inoperable	3	7 3

results than either surgery or irradiation alone. Doubtless the recently improved methods of administering irradiation may greatly increase the incidence of cures.

For survey purposes the special cancer charts recommended by the American College of Surgeons are a great aid and I would strongly urge their adoption and especially recommend that they be filled out while the patient is in the hospital, at which time only can all pertinent facts be elicited and recorded.

I would like also to endorse the plan which has been frequently suggested that definite periodic follow-up examinations be made in every case, having the patient report at sufficiently frequent intervals to insure the early detection of local recurrences, proper treatment of which so often avoids further extension and even distant metastasis.

TABLE VIII—CANCER OF THE FUNDUS—CARCINOMA 27 SARCOMA, 4 TOTAL, 31

	Cases	Percent
Treated before 1918	17	
Alive and well over 5 years	7	
Dead, 5 years after treatment		
Alive with recurrence after 5 years		
Total	8	47
Total receiving radical treatment	10	30
Treated before 1918	23	
Alive and well to 5 years		
Dead, to 5 years after treatment		
Total	4	18
Total cases treated	23	
Alive and well to 5 years	9	
Dead under years	8	
Total	17	60 7
Total treated	39	
Total living	8	62
Total dead	31	23
Total carcinoma cases	27	
Living	8	64 6
Inoperable cases		
4 sarcoma cases—one living 14 years—1, 5 months, 1, 6 months, dead at 3 months, without recurrence—cases treated 14		

TABLE IX—CANCER OF THE ADNEXA—SARCOMA, 1 CARCINOMA 27 TOTAL, 28

	Cases	Percent
Treated before 1918	1	
Alive and well over 5 years	1	9 99
Treated before 1918	4	
Alive and well to 5 years	4	28 6
Dead, after to 5 years	17	
Total treated		
Alive and well under years		
Alive with recurrence under years		
Dead, under years	8	64 1
Total		
Inoperable—not treated		
Only patient lived 5 years		
Total living		11
Total dead	24	80

TABLE X—SARCOMA CASES

Number of cases, 28.  
Number of inoperable, 17.  
1 compound, age 73 years.  
Oldest, age 76 years.  
Average time between onset and treatment, 6 months.  
Latest, after 44 years.

TYPE OF TREATMENT AND RESULT IN SARCOMA CASES

	Cases	Per cent of total
Alive and well to 5 years		
surgery		
surgery X-ray and surgery		
Alive and well under year—surgery	3	57
Alive with recurrence to 5 years—X-ray	3	57
Dead, having lived 8 years after treatment—surgery	3	57
Dead, to 5 years	14	28
surgery and X-ray		
surgery		
X-ray and radium		
1 inoperable		
Dead, under year	8	41
1 surgery		
1 surgery and X-ray		
1 radiotherapy		
1 X-ray		
1 inoperable		

AN AUTOMATIC METHOD OF TREATMENT FOR FRACTURES OF THE TIBIA AND THE FIBULA<sup>1</sup>

ROGER ANDERSON F.A.C.S. SEATTLE WASHINGTON

IN order to appreciate the need for new methods of fracture treatment we must remember that our criteria of end results have been altered with the change in the medico-legal aspect of cases. Since the establishment of compensation commissions, juries and insurance companies constitutes a final judge in so many instances, it behooves the surgeon to give this timely topic more serious consideration. Functional restoration, regarded in the past as the ultimate test, is now insufficient. The present public also demands a practically normal reposition of the bony fragments, as demonstrable on the final X ray films.

In line with modern fracture treatment, which aims toward surety of end to-end reductions, a simpler and yet more positive method is described for fractures of the leg requiring traction, especially those of the oblique variety. To our knowledge this is the first time that reduction has been mechanically achieved by an apparatus providing exact rotation, traction, and sidewise control all on the normal anatomical axis by means of skeletal traction and countertraction. In reviewing the subject of multiple pin methods we note Putti, Abbott, Pitkan, Boehler, Klapp and others as advocates but the majority of these authors manipulate four pins in order to appose the fractured ends or else use the method with devices for bone-lengthening. For many years we have been employing a two-pin method—in association with the regulation fracture table and also with the bilateral expansion bolts attached to the pin ends as reported by Dr. Nixon from my service at the King County Hospital.<sup>1</sup> Rotation was found to be unsatisfactory with the ordinary fracture table because of the difficulty of bringing the axes of rotation to coincide. As for the expansion bolts, the variable human element intervenes and since retention of fragments may be even more difficult than the setting reduction is often lost during application of the cast. If we are to be held liable for continued retention throughout treatment why should we take chances on trial and error methods known to result in a high percentage of fragment slipping during or following application of the cast.

To solve the problem of maintaining perfect apposition it was necessary to devise a new ap-

paratus, a small fracture table—only 20 inches long—with mechanism so adjustable that all the aforementioned discrepancies are overcome with an unremitting mechanical force. In a veritable fracture robot control has been so perfected over traction rotation and abduction or adduction that absolute reduction and immobilization are attained by the surgeon without skilled assistance. Hence the fracture is not only automatically reduced but the fragments are firmly held while applying the cast. And subsequently since the pins transfixing the upper and lower fragments are incorporated in the cast, there can be no loss of reduction.

Skeletal traction implies countertraction. The superiority of skeletal traction is now accepted by all surgeons who are acquainted with it, and once employed, skeletal countertraction will draw as many converts. A further advantage to be derived from double wire or pin transfixion is that the proximal fragment, as well as the distal, is under control in readiness for any form of direct bone manipulation. In this method the superior pin supplies the base for the counter pull while traction is made upon the distal pin. Thus the essential attribute of this new mode is skeletal traction plus skeletal countertraction, with a control fulfilling all conditions of adjustability besides allowing for modification of technique to fit all cases. In the majority of simple fractures and in many of the compound ones the splint is removed after application of the cast. With the older methods of treatment, when a complicating area of integumentous and soft tissue injury also demands immediate attention reduction is either postponed or made secondary to the non-osseous therapy. With our method the leg is merely left in the splint without plaster and therefore repair of the fracture, which is fixed in reduction becomes coincident with that of the soft tissues.

## DESCRIPTION OF THE FRACTURE ROBOT

The splint (Fig. 1) consists chiefly of an oblong aluminum frame *a* with two horseshoes, *d* to hold the pins or wire and a threaded rod *b*, the means of obtaining traction. These U shaped attachments, *d* are provided on their underside with a rack of teeth through which internal or external rotation is readily adjusted by turning the self locking handle, *b* moreover the horse

Nixon, E. A. Skeletal traction and pressure in treatment of fracture. *Ann. J. Surg.* 1923, xvii, 443.

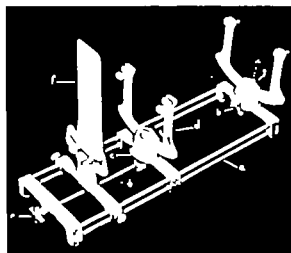


Fig. 1 The automatic splint. *a* Aluminum frame, *b* rotation adjustment handle, *c* sidewise control nut, *d* aluminum horseshoes to hold the pins, *e* traction handle, *f* removable foot rest.

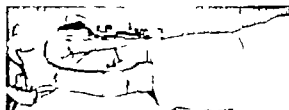
shoes are so proportioned to the rack that the axis of rotation coincides exactly to the axis of the tibia, the horseshoe base *g* being centrally pivoted, provides a sidewise swing for correction of medial and lateral angulation, *c*. The adjust-

able footrest, *f*, is fashioned so that the cast can be applied directly over it, because it is tapered it can easily be removed later.

#### TECHNIQUE OF REDUCTION

Immediate reduction is preferable, and edema, either ascending or receding, or vesicle formation need be no cause for postponement. Roentgenograms and hypnotic should precede manipulation performed under local, spinal, inhalation, or avertin, the local injection of novocain being the method of choice.

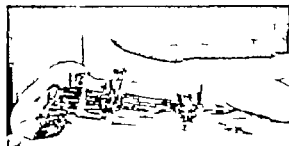
The preparation of the leg includes shaving and cleansing with soap and water, and then sterilization with ether and iodine, followed by alcohol should the iodine be very strong. An injection of 5 to 20 cubic centimeters of a 2 per cent novocain is made into the skin and down into the perosteum on either side of the tibia at both sites of transfixion, while 20 to 60 cubic centimeters are injected into the hematoma and around the end of each fragment. The distal pin is put straight through the center of the tibia at a point two fingers breadth superior to the tip of the internal malleolus (Fig. 2 A). Recently the site of the superior insertion has been changed to transfix the condyles of the tibia at their widest part midway between the anterior and posterior surfaces, just



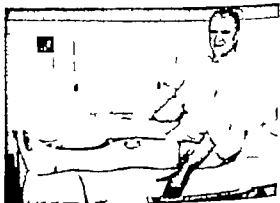
A.



B.



C.



D.

Fig. 2 Steps illustrative of routine reduction. A, First, transfixion of tibia by proximal and distal pins or wire. B, Second, leg placed in splint and fracture reduced, ready for roentgen check. C, Third, encasement of both leg and pins in plaster. D, Fourth, leg lifted free from splint; ends of pins are plaster-covered, and cast is cut out over patella and toes.

distal to the knee joint. Without incising the skin or preliminary drilling of the bone each stainless steel Steinmann pin is forced through by rotary hand pressure alone. Sterile dry dressings about 3 inches square, spiked over each pin-end afford an ample safeguard against infection; they are held close to the wound by a bandage of non-sterile sheet wadding.

The leg is now in readiness for the apparatus. By grasping the foot and pulling on it, the nurse—the only assistant required—raises the leg while the splint is placed beneath whereupon the pins are clamped to their respective horseshoes. The foot and ankle are then padded with sheet wadding special attention being given to protection of the heel. All malposition is now controllable; traction and rotation are adjusted, angulation is corrected, and the adjustable footrest is set. When the reduction is judged complete it is roentgenographically checked. Separation of fragments due to overtraction must be assiduously avoided because, notwithstanding perfect alignment, usually no result can be considered satisfactory without end-to-end pressure contact. Immobilization of satisfactory reduction is completed by the application of a cast, which firmly incorporates the pins and generally extends from mid thigh downward over the foot plate to slightly beyond the toes. The sole of the foot should be reinforced with a 4 inch plaster bandage. When the plaster is set, the pin clamps are loosened and the leg in its cast is lifted free from the horseshoes and from the foot plate. Occasionally this process is facilitated by loosening the screws of the foot plate. Ordinary corks are placed on the ends of the pins, which are then covered and fastened to the cast by a plaster bandage. A window cut over the patella serves for subsequent mobilization of the cap, that cut out over the dorsum of the toes allows freedom of movement. The cast is completely cut through to the sheet wadding from top to bottom and later spread open if necessary.

#### OPTIONAL TECHNIQUES

Piano wire permits of the same technique when used in conjunction with an original wire-tightener constructed as an integral part of a stainless steel horseshoe (Fig 3). It is operative in the following manner. The bolt, *n*, is first unloosened in order that the tightener can be set well up against the horseshoe before clamping the wire and when the tension bolt, *n*, is fully screwed in the wire is sufficiently tight. As soon as reduction is effected the horseshoes, as well as the wires are incorporated in the cast. We await only the drying of the plaster before releasing each horseshoe from

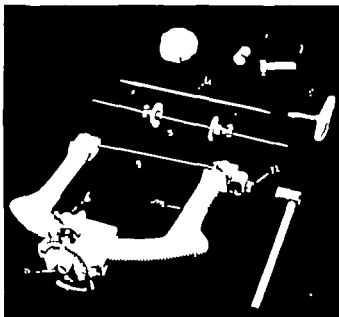


Fig 3 Accessories for optional techniques. *b* Rotation adjustment handle *c* stainless steel horseshoe for Kirschner wire with our original wire tightener *d* wire tension adjustment bolt *e* alldewick swivel stud *f* piano wire *g* wire tightener wrench *h* kiddie kar spoke used as wire *i* and *j* two wire tautners the one on the left is contracted, while that on the right is expanded *k* ordinary 8 inch Steinmann pin *l* pin handle *m* felt washer *n* ordinary cork *o* metal cap to cover pin ends.

its base by removing bolt, *i*. Hence the leg is removed from the apparatus with the horseshoes molded in the cast, contrary to the preceding technique of incorporating the pins without the horseshoes.

For those who prefer wire on theoretical reasons alone, a special technique has been devised whereby the sides of the cast become the instrumental means of keeping the wire tight during convalescence (Fig 3 *s*). Continued need of the horseshoes and annoyance of extra weight in the cast are thus done away with. For this therapeutic agent an ordinary kiddie kar spoke or spring steel wire 65/1000 of an inch in diameter and 9¼ inches in length, is sharpened and tempered at one end. Technique of inserting and clamping this special wire in the horseshoes is the same as for the piano wire. These wires are incorporated in the cast, but the plaster is fashioned with a perpendicular face immediately around each wire to serve as a base for the compression washers. The compression set screw washers are next screwed in and the slots in the washers adjusted so that the set screws can be put on the wires (Fig 3 *t*). The wire-tautners after being pushed tightly against the cast are fastened to the wire with a screw driver. When the cast is fairly hard the tautners are ex-



Fig. 4. Mrs. K. R. A, double fracture of tibia and fibula, B immediately after reduction.

padded with a wrench up to that point where the washers begin to press into the cast. The wires may now be released from the horseshoes; the ends should be protected with corks and plaster; however, if no further manipulation is anticipated, the wires may be cut off close to the set collars.

*Modification of and accessories* to routine technique are occasionally indicated in obtaining end-to-end reduction. In some cases flexion of the knee may be the essential factor in correcting angulation, accomplished by placing the splint on a box or by setting a sand-bag under the superior end of the frame. In an occasional fracture it may be expedient to elevate the distal end of the apparatus. Persistent anterior angulation can be corrected by a padded compression bandage over the deformity fastened down to the parallel rods of the frame. Posterior angulation can be overcome by passing a folded towel under the deformity and lifting it up, holding it in position until it is set in the plaster. Altering the tension on the gastrocnemius muscle through adjusting the pressure of the footrest against the sole not infrequently aids in the reduction process.

If the exigencies of the case demand trans-



Fig. 5. Extensive compound fracture of tibia involving the ankle joint, in which pin transfixed the os calcis. A cast opening made immediately superior to the wound facilitated diagnosis of a possible gas infection, opening later enlarged to treat a traumatic ulcer.

fixion by pins or wires may be made through the os calcis or through the distal end of the femur; in the event of a double fracture, a third pin may be of assistance.

The cast may either be padded or unpadded, the knee either flexed or extended, but nothing less than a smooth snug, but non-constricting application will suffice in either instance. It may be occasionally expedient to apply the cast in sections, that is, to incorporate the upper and the lower pan and the immediate vicinity in its respective short cast and to leave the injured area free and exposed for inspection during reduction, for daily therapy or subsequent operation. These sections may be connected immediately by the third division of the cast and the splint then detached; on the other hand, the two segments may remain separated with the leg left in the splint for as many days or weeks as required.

#### AFTER-CARE

As the majority of cases are reduced immediately under local anesthesia with surprisingly little attendant shock, if any at all, the patient should be encouraged not only to use the wheelchair but to walk with crutches. For the latter purpose felt or bath sponge is strapped to the sole or perhaps a rubber overshoe or a split shoe slipped over the foot portion of the cast. For the fastidious or those who wish to resume office duties immediately a canvas or leather moccasin, soled with felt, may be inexpensively and quickly fitted on. Leg weight bearing is permitted with

a day or two but body weight is not allowed the first few weeks.

We cannot overemphasize the importance of maintaining pressure contact between the ends of the main fragments even at the expense of some shortening or slight misalignment at the fracture site. In the normal process of repair loss of contact not infrequently occurs from absorption at the ends. To re-establish direct contact the cast may be split, even as early as the end of the first week, from its upper edge down to the fracture level and the plaster cut out directly distal to each end of the superior pin. Then the pin is displaced downward in the cast for a distance of 1 to  $\frac{3}{8}$  of an inch. The loosened pin, which has not been changed in its position in the bone is generally re-incorporated at this time although conditions may indicate leaving the pin free in the small slot in the plaster. To ensure continued contact this pin may be entirely removed as early as the third week. Weight bearing in alliance with this pressure contact assists in provoking early union through the benefits of friction stimulation.

The pins and wire are usually left in for a 3 to 6 week period, and during this interval no attempt should be made to inspect or to dress the wounds. Many years experience of securely incorporating pins, tongs, or wires in plaster warrants the statement that bone infection does not follow a sterile insertion. Moreover a pin that is covered and securely incorporated in plaster is usually painless and remains without the patient's knowledge until its removal.

To remove a pin a 4 inch hole is cut on the medial side of the cast and the area cleared to the skin. All plaster is removed from the pin with boiled tap-water. It is further cleansed with a rotary motion of sterile gauze dressings saturated first with ether and the movement repeated with iodine. Iodine saturated gauze is then held closely to the skin around the pin while the pliers withdraw the pin from the opposite side. Dry sterile gauze suffices as subsequent dressings for the pin wounds. If wire has been employed a similar hole is made in the cast and the wire is cut flush with the skin with sterile pliers. The end is cleansed with ether and iodine before it is pulled through from the opposite side.

At this time or a few days later a new well fitting cast—padded or unpadded—is applied extending to the knee or to the mid thigh. The plaster cast is protected by an overshoe as previously described. If desired an iron walking stirrup can be incorporated but its transverse portion should be covered with felt or bath sponge



Fig 6 Mr J F A, Before reduction B and C lateral and anteroposterior views afterward.

fastened with adhesive in order to prevent the patient slipping and to remove the noise and jar while walking. Body weight bearing is permissible the following day provided roentgen examination reveals sufficient callus.

The relatively high incidence of delayed and non-union in shaft of tibia fractures generally noted in monographs on this subject, will be greatly reduced with a system wherein the physiological benefits of immediate ambulation and leg weight bearing are coincident with the maintenance of absolute end-to-end reduction. But in the event of delayed union, perhaps due to arterial or constitutional factors, the cast should be reapplied at 1 or 2 month intervals, body weight bearing being dependent on callus formation. With these measures many cases of open operation can be avoided.

#### COMPOUND FRACTURES

For fresh non-extensive compound fractures traction is obtained in the routine manner. Should the wound encroach transfixion can be made through the os calcis or the distal end of the femur. The wound can be cleansed by first pouring in ether followed by iodine, while the skin is centrifugally painted with iodine. Badly traumatized or necrotic tissue should be excised thoroughly but not ruthlessly. Débridement may or not precede reduction depending on the character of the wound. Closure of the wound is made with mattress sutures of silkworm gut, carefully



Fig 7 Mrs F E A, Compound fracture with over 2 inches of tibia protruding through skin B reduction obtained with pin through os calcis C illustrating posterior displacement D reduction checked with leg in splint after thick routine cast was applied

spaced so that the circulation is not strangulated for the skin edges. In the anticipation of much interstitch serous drainage the wound may be left exposed through a hole in the cast for benefits of open air therapy. These fenestrations serve as diagnostic loop holes for early detection of gas bacillus infection.

In extensive compound fractures or those which do not receive treatment during the first 12 hours after trauma we advocate Orr's method. After cleansing and débridement, as outlined the wound is lightly packed with vaseline saturated or Bipp's gauze and then covered with an occluding plaster cast. A window cut superior to but not exposing the wound facilitates the early diagnosis of gas or infection. Should such an infection or an abscess formation occur the corks are removed from the ends of the pins and the leg replaced in the apparatus. All or part of the cast

can then be removed thus exposing the leg for surgical treatment without endangering reduction.

A compound fracture may be so complicated by soft tissue injuries as to preclude the use of a plaster cast. Such a situation is well met by the retention of the leg in the splint. It may be left completely exposed for as many weeks as necessary while the wound, the skin lesions, and the fracture are receiving simultaneous repair.

If the patient is referred for treatment so late that the compound fracture is already augmented by traumatic osteomyelitis, draining sinuses, or abscesses, treatment can be followed as above described. Moreover if Baer's method is preferred, the leg may be retained in the splint with full exposure, or a window may be made in the cast for supervision of the maggot farming.

For those who prefer to treat compound fractures by chemical irrigation methods, the insertion of the pins or wire and the placement of the leg in the splint are made in routine manner. After cleansing and débridement the tubes are inserted. The leg can be left in the splint during convalescence, but to ensure the leg from sliding on the wire, "thick felt buttons" (Fig 3 w) or large corks slipped over the wire, should occupy that space between the leg and the side of the horseshoe. If the wound is central, each pin or wire may be encased individually in its own short plaster segment, leaving the central portion of the shaft open for treatment. All cases of compound fractures are given a prophylactic combined injection of antitetanus and gas bacillus serum.



Fig 8 Illustrating location of transfusion site and manner of inserting the lower wire or spoke performed under local anesthesia.

## SOFT TISSUE INJURIES OR COMPLICATIONS

For fractures associated with burns loss of skin large ulcers severe soft tissue injury with gangrenous sloughing, or late soft tissue complications, the technique for chemical irrigation is adhered to. With the patient movable and the whole leg exposed, local treatment or plastic surgery can be carried on without interference or postponement of reduction and union.

## MALUNION AND NON UNION

This method is admirably adapted to malunion and non-union for the splint is small and readily sterilized in the autoclave. For open operation the entire leg besides several inches above the knee is surgically prepared and draped preliminary to inserting the pins (Fig 9 A). The pin ends must be covered with ordinary corks or with metal caps (Fig 3 y, z) to prevent an accidental perforation of sterile sheets or operator's gloves. The gloves are then changed and with the continuation of sterile technique the necessary incision is made to free the malunion and to freshen the bone-ends, after which the leg is placed in the splint and clamped in position (Fig 9 B). In simple malunion the fracture is visibly reduced, and only soft tissue sutured preparatory to encasing the leg and pins in the routine cast.

For the more difficult non unions, the technique is the same as for malunion, with the exception that the sliding bone-graft is prepared and slipped into position where it is positively held by the automatic splint. After closure of the skin, application of the cast is immediately made with assurance of no loss in reduction or displacement of graft (Fig 2 C). This saves that embarrassing moment of finding that the graft shifted while applying the plaster, a rather common disclosure with the older methods.

## ADVANTAGES

Of the many advantages of this new method its chief merits are the ease of obtaining and the positiveness of holding reduction, both at time of application of cast and during convalescence.

Double pin or wire transfixion provides all the benefits of skeletal traction plus those of skeletal countertraction. Both the upper and the lower fragments are individually under direct control during apposition of the fractured ends. Further more, by literally nailing the bones to the cast, we gain definite insurance against any later displacement. It is this anchoring of reduction that permits immediate ambulation with its many physiological and economical benefits. For instance, movement on crutches increases muscle tone and improves the circulation, locally and generally with increase of appetite and betterment of digestion. Since long continued hospitalization under traction and that annoying daily adjustment are dispensed with this method proves a boon to all.

The chief requisite in obtaining reduction of leg fractures is traction, amply supplied by the splint. This advantage is not without an attendant danger as so much traction at one's command must be controlled. Too much traction must be avoided as non union can be frequently attributed to this factor. Direct pressure contact before leg is placed in cast is imperative to reduction, even at the sacrifice of slight overriding.

This automatic splint, acting as a fracture robot, obviates the necessity of skilled assistants. Too much reliance on human assistance, with the fatigue element intervening, is creative of uncertainty and anxiety as to maintenance of reduction. But the surgeon acquires full confidence on initial usage of this mechanical assistant because variation in tension is incompatible with the vice-like arrangement that holds the reduced fragments.

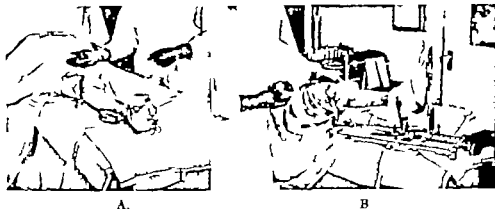


Fig 9. Technique for malunion or non-union is similar to routine reduction except that the whole splint is sterilized and that reduction is carried out under the eye as demonstrated by A and B.





Fig 10 Mrs K R a case received in malunion. A, Before operation. B, result obtained by osteotomy and utilization of the splint sterilized.

Selection of procedure from a triad of special techniques will fit any case in which immediate or late complications limit the use of plaster of Paris. When an extensive soft tissue injury demands daily therapeutics, the leg may be left in the splint, entirely exposed for as many days or weeks as necessary. The advantages are evident, in that there is simultaneous repair of both bone and tissue under the most advantageous conditions. These patients can be easily moved by wheelchair out of doors, to surgery or to X ray room. To meet other conditions the cast may be applied by incorporating the upper pin in a short section, and likewise incorporating the distal pin in another section, leaving the central intervening space entirely free of plaster. This precludes any side-to-side bone movement upon the pin or wire in the horseshoes, and also any motion at the knee or ankle. On healing of the lesion, this exposed section is covered by a cast which is connected with the upper and lower segments, whereupon the splint is detached with the added advantage of crutch ambulation. Another technique illustrates the adaptability of the method to change during the course of treatment for the plaster encased leg may require attention, when some sequelae develop, such as an abscess formation. The leg is therefore replaced in the splint, then all or any portion of the cast is removed. This is attained without endangering reduction.

Ease of obtaining end-to-end reduction is attributable, to a large extent, to the precision of rotation construction. It provides for individual

rotation of the fragments on their exact anatomical axes. Horseshoes of different widths are used with the assurance of still having the axes of rotation coincide. An oblique transfixion through the tibia, due perhaps to hasty technique or through necessity of encroaching wounds, in no way prevents a normal axial rotation. Moreover, the special foot plate is adjustable to correspond with the rotation of the foot.

Fluoroscopic or roentgen examination is not interfered with by intervening shadows or obstructing metal parts, either at the time of reduction, or later should the fracture tablette be retained. Since reduction can be checked and then perfected before immobilization in the cast, this method eliminates the expense and worry of wedging or recasting. The fact that the patient is ambulatory by crutch or wheelchair solves the problem of using the X-ray in the small hospital with no portable machine. When it is obligatory to retain the leg in the splint, that is, without plaster coverage the patient can still be moved. Because of its size the apparatus is readily portable like an automaton, it has no attachment with bed ropes, or weights.

With perfect alignment, which warrants early leg weight bearing it is obvious that this new therapeutic agent shortens the period of disability of great concern to the modern surgeon. Since most of these patients are crutch ambulatory and visit the doctor for inspection and X ray checkup, hospitalization is reduced to the minimum.

The fact that the machine is small enough to be easily sterilized in itself inaugurates a new method of treating malunion, non-union, and the unusual compound fracture. For any type of compound fracture this method lends itself admirably and as well to any current procedure.

The fundamental principle of the method—skeletal traction and skeletal countertraction as employed with the mechanical tablette—remains the same regardless of mode of procedure. Furthermore, the flexibility of the method permits a wide selection of transfixion means the Steinmann pin, Kirschner wire, or spoke with tautness immobilization maintained with or without plaster-of-paris fixation the cast, padded or unpadded the knee in flexion or extension and choice of anesthesia to suit the case. With only a few minor changes, the method has been successfully adapted to fractures of both bones of forearm.

#### SUMMARY

An original method of treating fractures of the tibia and fibula has been described, whereby fragments are automatically aligned and immobilized.

## SURGICAL ASPECTS OF POLYCYSTIC KIDNEY

REPORT OF EIGHTY FIVE SURGICAL CASES<sup>1</sup>WALTMAN WALTERS M.D., F.A.C.S. ROCHESTER, MINNESOTA  
Division of Surgery The Mayo Clinic

AND

WILLIAM F. BRAASCH, M.D. F.A.C.S. ROCHESTER, MINNESOTA  
Section on Urology The Mayo Clinic

REFERENCES to standard textbooks and other literature would indicate that there is uncertainty regarding the advisability of surgical treatment for polycystic kidney and that there are but few data available in regard to the results of treatment. This, we believe, is largely the result of too few cases having been studied to allow of definite conclusions being drawn. In one of the recent textbooks, reference is made to the report of Brin, in 1905 as follows: 'Nephrectomy was carried out in 17 cases—the mortality has been so high that this procedure stands condemned.'

Our experience would seem to lead to a contrary opinion. A review of our records shows that some type of surgical procedure was performed at The Mayo Clinic on 85 patients who were found to have polycystic kidneys. Nephrectomy was performed in 31 cases. The Rovsing operation (puncture of cysts) or excision and drainage of the cysts, was carried out in 29 cases, and exploration, either with or without an associated operation on some other abdominal viscus, was performed in 25 cases.

## INDICATIONS FOR SURGICAL INTERFERENCE

Since most of the symptoms accompanying polycystic kidney are secondary to renal insufficiency or vascular disease, the majority of patients will present themselves to the internist rather than to the surgeon. However with the onset of pain, hæmaturia, tumor or secondary renal infection, the surgeon is usually consulted for relief.

The indications for surgical interference may be either primary or secondary. The primary factors are pain from distention of cysts and persistence of hæmaturia. Among the secondary complications are localized or diffuse renal infection, with pyonephrosis, renal abscess, lithiasis, tuberculosis, and neoplasm. Surgical measures may be required for evacuation of cysts, in order to relieve intrarenal pressure and prevent further injury to the remaining renal tissue as suggested by Rovsing.

In determining the advisability of operation from the standpoint of combined renal function, the peculiar conditions at hand present unusual problems. In the first place, as one of us has previously noted, lack of parallelism between the excretory and retention tests of renal function is often observed with polycystic kidneys. In other words, there is often marked delay and reduction in excretion of such dyes as indigocarmine and phenolsulphonaphthalein, while the values for blood urea and creatinine may be normal or but slightly elevated. This may be explained in part by intrarenal anatomic conditions causing delayed excretion. The retention test, therefore, usually will be the more accurate index of renal function. If the value for urea is more than 50 to 60 milligrams for each 100 cubic centimeters of blood the advisability of operation is open to question except as an emergency measure, or when some temporary functional deterrent may be present, such as lithiasis or acute unilateral renal infection. In the light of our present experience, intravenous or excretory urography is a comparatively accurate index of renal function. Recognizable deformity will be visualized in fully two-thirds of the cases when the renal function will permit visualization. The details of the pelvic outline may be insufficient for interpretation however and the condition may not be recognized unless retrograde urography is employed. As a means of determining the comparative function of the two kidneys intravenous urography will be of great practical value also. Adequate visualization of the pelvis of but one kidney can be regarded as sufficient evidence of normal renal function to warrant removal of the other kidney. In the interpretation of the intravenous urogram one should remember, however that visualization of the renal pelvis may be absent or exceedingly dim with (1) idiosyncrasy on the part of the patient in excretion of iodine (2) combined renal insufficiency as indicated by a value for urea of 60 milligrams or more in each 100 cubic centimeters of blood and (3) some temporary reflex inhibition of renal excretion.

<sup>1</sup>Read before the American Association of Genito-Urinary Surgeons, Washington, May 8 to 10, 1913.

**Pain.** In most of our series of 85 cases in which surgical procedures were carried out, a complaint of pain was made. It was usually referred to as a dull ache localized largely in the lumbar region. In the presence of huge kidneys, pain may be caused by tension on the renal pedicle. Pain may also be caused by increase of intracystic pressure, particularly when the cysts are of extremely large size. In several cases one or two large cysts were present and their evacuation was followed by relief of pain. Intracystic hemorrhage, with resulting overdistention, may occur and may be the cause of renal pain. Pain may also occur as the result of ureteral obstruction by blood clots.

**Hemorrhage.** In a recent review of clinical data concerning 193 patients with polycystic kidney observed at the clinic, it was found that gross hematuria occurred in 30 per cent. The combination of hematuria with a tumor felt in a lateral upper abdominal quadrant is usually so suggestive of neoplasm that surgical exploration and even nephrectomy have frequently been reported before the true condition was recognized. In most cases the hematuria is moderate and continues only a few days. Intracystic hemorrhage probably occurs often with polycystic kidney without hematuria. On cross section of the kidney cysts are often found, containing dark colored material, which very evidently represents the residue of a previous hemorrhage. If intracystic hemorrhage is very slight or intermittent neither pain nor hematuria may occur. However if the hemorrhage is continuous, the cysts either become distended and cause severe pain, or they may rupture into the renal pelvis with resulting hematuria. If the hematuria is excessive or long continued, surgical interference may be indicated. Evacuation and drainage of these cysts, particularly when large, may suffice. Should there be evidence of secondary widespread renal destruction, nephrectomy may be necessary. Incidentally it should be remembered that hematuria with polycystic kidneys does not necessarily signify its renal origin. Coincident bleeding from other parts of the urinary tract often has been observed, and their exclusion from consideration, by means of cystoscopy usually is necessary.

**Renal infection.** Urinalysis will disclose the presence of a small amount of pus in the majority of cases of polycystic kidney. Many patients will complain occasionally of intermittent frequency of micturition or of dysuria. As the cysts become distended and project into the lumen of the calices they can readily cause inadequate drainage of the urine with secondary infection. It is surprising that infection which requires surgical treatment

does not occur more frequently in these kidneys. Such infection is usually found in one kidney only suggesting its anatomical origin. Widespread renal infection may have a most insidious onset and may not give rise to acute symptoms until the renal tissue is largely destroyed. Infection of intracystic origin, confined to one or more adjacent cysts, is often observed. Perinephritic abscess, having its origin in infected cysts, may occur. Stone is occasionally found with polycystic kidney and probably occurs secondary to insufficient drainage of a calyx. Calculi were found in 5 of the 85 cases and were accompanied by so much infection that nephrectomy was necessary. Chemical examination revealed that they were composed largely of calcium phosphate and were probably found as a result of inadequate renal drainage.

#### INCISION, EXCISION AND ENUCLEATION OF THE CYSTS

Incision, excision, and enucleation of cysts are used to accomplish relief of pain caused either by pressure of the polycystic mass on adjacent structures or by intracystic distention. When the cysts are of moderate size, multiple puncture, as suggested by Rovsing, is the preferable procedure. This may be combined with excision or enucleation of larger cysts which may be accessible to such procedures. With infection present within the cysts, unless complete drainage of the perirenal region is established the infection may extend into the remaining renal as well as perirenal tissues, and nephrectomy will be required. For this reason, operations of this type should not be undertaken unless one is certain that the function of the opposite kidney is capable of sustaining life. The results of incision, excision, and enucleation of cysts of polycystic kidney are variable. Rovsing reported several cases in which remarkable amelioration of pain occurred subsequent to multiple puncture. In addition, the renal function was considerably improved. Other surgeons have confirmed these results in some cases, whereas others have reported failures, and have found that secondary nephrectomy became necessary later. Brun reviewed 16 cases treated by incision of cysts, and stated that there was a mortality rate of 35 per cent in this series, and that results among patients who lived were uncertain.

In our series there were 24 cases in which the Rovsing operation, or puncture of multiple cysts, was performed and 5 additional cases in which cysts were removed or enucleated. There were 4 deaths in hospital from uræmia, perirenal and retroperitoneal bleeding, and infection this gives

TABLE I.—ROVING OPERATION AND REMOVAL OF CYSTS

	Patients	Deaths in hospital
Roving operation	24	4 (16.6 per cent)
Removal or enucleation of cysts	5	
Total	29	4 (13.8 per cent)

## Survived operation (25 cases)

Patients now living	13
Less than 3 years	2
8 to 21 years	11
Patients now dead	7
Lived more than 10 years	1
Lived 5 to 10 years	3
Lived 3 to 5 years	2
Lived less than 3 years	1
Not traced	5

a mortality of 13.8 per cent. Thirteen of these patients are living and in fairly good health at the present time, after periods varying from 3 to 21 years following operation. Subsequent deaths occurred in 7 cases, in periods varying from 1 to 17 years (Table I)

## NEPHRECTOMY

Nephrectomy was indicated and performed in 31 cases. There was but 1 death as the result of this operation the patient was a man, 67 years of age, whose removed kidney also contained an adenocarcinoma graded 3. The youngest patient was aged 21 months, and the oldest, 69 years. Nephrectomy was performed for the most part because of advanced renal infection associated with marked reduction or destruction of renal function. Included in this group were 5 patients with calculi and 3 with malignant disease. In 3 of the cases, nephrectomy was performed as a secondary procedure subsequent to puncture of cysts (Roving operation). Eighteen patients of this group are living at the present time, from 1 to 19 years after operation. Particular attention is directed to a patient 43 years of age at the time of nephrectomy, who has reported his condition as being excellent 19 years after nephrectomy. The patient who was 21 months of age at the time of nephrectomy has been in good health during a period of 14 years and 4 months (Table II)

Practically all of these patients who have lived more than a year have reported their condition to be good or excellent, with the following exceptions. After a period of 9 years, one patient reported some pain in the opposite renal region. Another after 7 years, reported enlargement of the remaining kidney and hematuria, another reported hematuria and dysuria 1 year and 7 months subsequent to nephrectomy. Three patients who

TABLE II.—RESULTS FOLLOWING PRIMARY NEPHRECTOMY FOR POLYCYSTIC KIDNEY (28 CASES)

	Patients	Per cent
Now living	18	64.2
After 19 years	1	
13 to 19 years	4	
7 to 13 years	3	
4 to 7 years	3	
8 months to 4 years	7	
Dead	5	17.85
Lived 9 to 13 years	2	
Died within 3 years	2	
Died in hospital	1	
Not traced	5	17.85
Nephrectomy was performed secondary to Roving operation in 3 additional cases.		
Total number of nephrectomies	31	
1 patient died in hospital mortality	3.2 per cent	

were subjected to nephrectomy secondary to the Roving operation died subsequently, 1 after 8 years, 1 after 6 years and 5 months, and 1 after 2 months. In all 3 cases death was due to uræmia.

## SURGICAL EXPLORATION

Explorations of polycystic kidneys, without other surgical procedures on them were carried out in 25 cases. In 11 of these cases intra-abdominal operative procedures were carried out for lesions of one or another of the intra-abdominal viscera, and the presence of polycystic kidneys was an accidental finding. The discovery of polycystic kidneys in the course of abdominal operations in so large a number of cases is suggestive of clinical negligence. However, many of these patients were operated on before methods of diagnosis were as accurate as they are at present. Furthermore, it is surprising how often bilateral renal enlargement is not detected in abdominal palpation. Owing to the great difference in degree of involvement which often occurs frequently only one kidney is found enlarged on palpation. This may account for the erroneous clinical diagnosis of renal neoplasm which is often made and with possible disastrous results, if nephrectomy follows. With the aid of modern methods of diagnosis and particularly with the more general employment of intravenous urography attention should usually be called to the condition present, even if other clinical data fail.

Coincident cysts in the pancreas, liver and other organs which might confuse the clinical picture are often found in the course of abdominal exploration. These cysts are usually confined to a limited region, usually are not progressive in size or number and do not seem to affect the function of the organs involved. They may occasionally

TABLE III—EXPLORATIONS FOR POLYCYSTIC KIDNEYS

	Number	Poly cystic kidneys
Patients	14	11
Died in hospital	1	0
Mortality per cent	7.1	
Now living	6	5
Now dead	6	6
Not traced	1	

*Accidentally found at time of other intra-abdominal operations*

become very large, in one case in which we performed exploration, a cyst of the liver was found to be of such size as to cause caudad displacement of the kidney to the level of the crest of the ilium. Occasionally large cysts are found in the liver and in other organs, without renal involvement.

Major surgical procedures were carried out in this group of cases, for cholelithiasis, uterine fibromata, duodenal ulcer and appendicitis, and in one case colostomy was performed for carcinoma of the rectum. None of the patients died subsequently over periods of from 1 to 10 years. Five patients of the group are living, for periods varying from 6 to 10 years; 2 of them are in good condition (Table III).

It would seem, therefore that intra-abdominal surgical operations can be carried out in the presence of polycystic kidney without appreciable increased risk, provided combined renal function is within normal limits.

#### SUMMARY AND CONCLUSIONS

The contention that surgical treatment of polycystic kidney is seldom, if ever indicated is erroneous. Complications with polycystic kidney which require surgical treatment, occur frequently. The estimation of renal function is of fundamental importance in determining the prognosis and the advisability of operation. Because of the anatomical conditions present in the polycystic kidney, retention tests of renal function usually give a better index than excretory tests.

Evidence of marked disturbance of function of both kidneys such as is indicated by a value for urea of 50 to 60 milligrams or more for each 100 cubic centimeters of blood, usually will contraindicate surgical treatment except as an emergency measure. When complications exist in one kidney, which would indicate nephrectomy, it is

essential first to determine whether the degree of function of the other kidney is sufficient to sustain life. Bilateral renal deformity visualized by intravenous or excretory urography should serve in many cases to call attention to the possibility of polycystic disease. It should also serve to make evident the comparative degree of function in either kidney and so govern the type and the advisability of operation. A polycystic kidney where a clinical diagnosis of renal tumor had been made, has been removed not infrequently. The most common complication requiring surgical treatment, occurring with polycystic kidney is diffuse or localized infection. Diffuse, subacute renal infection may have an insidious onset, and there may be but few localizing symptoms. Renal pain is a common symptom and is usually described as a dull ache although it may become acute. It may be caused either by excessive renal weight exerting a pull on the renal pedicle, by intracystic or external pressure, or by infection. Puncture or enucleation of one or more large cysts may serve to ameliorate or eradicate pain. Hematuria, usually of moderate degree and limited duration may become copious and long continued. Such hematuria is usually the result of intracystic hemorrhage with rupture of the cyst into the renal pelvis. Excision or enucleation of such cysts usually will suffice to control the hemorrhage. Should destruction of the kidney be extensive or accompanied by secondary infection, nephrectomy may be necessary. Other complications observed with polycystic kidney are renal calculus, neoplasm, tuberculosis, and hydronephrosis. The value of the Rovsing operation, which was conceived for the purpose of removing pressure by the cysts on the remaining renal parenchyma, still remains undetermined. Theoretically it has much in its favor. Unfortunately secondary infection or a persistent urinary fistula may develop following the operation necessitating nephrectomy. If such complications could be obviated, the procedure might well merit further consideration. It is difficult to evaluate the results obtained in the few cases in which the Rovsing operation was successfully carried out. Although many patients lived for a long time after operation, this is equally true in cases in which surgical treatment was not employed.

## A TWO STAGE OPERATION FOR FISTULA-IN-ANO

J HALL ALLEN A.B., M.D. AND BENJAMIN HASKELL, M.D. PHILADELPHIA

From the Department of Proctology of the Surgical Service of Dr. Thomas A. Shallow Jefferson Medical College Hospital, Philadelphia.

**A**N important feature in the surgical management of fistula in-ano is the prevention of deformity of the anal sphincters with consequent impairment of their function. That some degree of incontinence following operation for fistula was a frequent complication in the past is evident by the fact that one frequently heard the opinion that some impairment of sphincteric function was to be expected. Today interference with anal continence should not follow operation for fistula. It is our belief that this can best be achieved by a two stage operation, and this report presents our experience with this type of procedure in 266 cases of anal and rectal fistula.

All descriptions of the operative technique for fistula emphasize the necessity for a careful localization of the internal opening in the internal and complete varieties and for the determination of the various ramifications of the fistulous tracts. The latter are then completely excised or incision and proper drainage will be sufficient when tracts extend deep into the pelvis, laterally into the buttocks, or anteriorly into the groin.

To eradicate the infection completely and to remove the source by which the fistulous process has been maintained, the overlying tissues must be completely severed. This will include the external sphincter where the internal opening is found near the anal margin in a fissure or anal crypt, and also the internal sphincter where the internal opening is in or above it. It is generally held that the external sphincter may be cut through with little fear of disturbance in function so long as the muscle is severed at right angles to the direction of its fibers. Whenever the external sphincter is severed due regard must be given to the disturbances that may follow if satisfactory union of its ends does not take place. Proper function of this muscle is essential in maintaining the closing tonus of the anus. The internal sphincter is far from adequate in performing this function. Matti estimated the importance of the external sphincter as maintaining 60 to 65 per cent of the total closing tonus, since, when its influence is removed, the internal sphincter acts peristaltically and maintains only a transitory resistance to a dilating force. He found that the internal sphincter assists in closing the anus by mechanical not reflex stimulation of its intramuscular plexus by the persistent tonus of the external sphincter.

Various methods have been advocated and are in use for dealing with the anal muscles. With a grooved director passed through the fistulous tract and internal opening the overlying tissues and the sphincter are incised (1). Or the fibrous tract may be excised and the muscle severed at the point where the internal opening is found (3, 5, 7). In both types of operation nothing further is done to the severed muscle except to avoid too firm or prolonged packing. The muscle ends rarely heal by direct union a small amount of retraction of the ends always follows severance of the muscle and, as a result, a variable amount of scar tissue fills in the space. Depending upon the firmness of this scar tissue or its amount in relation to the anal canal and muscle, sphincter function will be normal or impaired. After excision of the tract, Martin removes all overhanging tissues, even if a portion of the sphincter arc is sacrificed. He finds that this flattened scar will present an even surface for the remaining portion of the sphincter to contract against giving a surprising degree of control. Buie emphasizes the importance of properly packing the wound and states that a solid block of scar tissue will form throughout the extent of the wound. The anal sphincters will then grow to the scar tissue and close the anal canal efficiently.

Less frequently radically different procedures have been mentioned. The cut ends of the sphincter may be sutured to the deeper muscles, the internal sphincter or levator ani (11). If the muscle must be cut through laterally Longacre suggests that the sphincter be reconstructed by three or four mattress sutures.

These procedures prove satisfactory in the majority of cases. Occasionally however in spite of careful postoperative care the resultant scar is irregular and distorted, and cannot act as a suitable fixed point against which the sphincter may pull. Some degree of incontinence, therefore follows. Perhaps these untoward results may be due to variation in the structure of the external sphincter. As Hiller pointed out so well the external sphincter consists neither entirely of fibers encircling the anus, nor of fibers extending anteroposteriorly, but is a mixture of the latter type with fibers encircling the anus either anteriorly or posteriorly, in varying proportions. His work showed, further, that the springing

apart of the cut muscle ends, the factor affecting confidence, is, in part, prevented by the fixation of the sphincter muscles to the skin and mucous membrane by the fibro-elastic terminations of the longitudinal bowel coat, as well as by the fibers of the external sphincter which encircle the anus posteriorly and end in the levator ani muscles. On this basis he explains the advantage of cutting the sphincter at a second stage when it has become firmly fixed to surrounding structures by fibrous tissue.

Bile suggests a multiple stage operation in very extensive and complicated fistula, where wide spread dissection and much loss of tissue is necessary. In such cases, the external sphincter is not severed until the wounds external to it have practically filled in. However a two or more stage operation has not been generally advocated. In 1907 Pennington described his so called "seton method" for operation on fistula to preserve the contour of the anus as well as its muscular function. Briefly the method was as follows. Over a grooved director in the fistulous tract, an incision was made from its distal end to a point close to the anal wall. The knife was then turned and an incision made on the proximal side of the tract, "salmon's back-cut." A seton was next passed through the opening entering the bowel and tied loosely around the tissue remaining and undivided. The seton consisted of a narrow strip of gauze which was replaced in 72 hours, when the wound was redressed, by another of one or two strands of heavy silk or linen. Later when the wound had filled in and healing had extended down to the thread, the tissues, previously undivided, which included the sphincter were then cut through and through. By operating thus, Pennington found that no deep sulcus was left to mutilate the anus, as frequently followed the usual plan of dividing the muscle. The internal opening in its relation to the tract could be altered so that the muscle would never need to be cut at an oblique angle to its fibers. The theoretical objection that there would be constant reinfection from the setonized tract, which would prevent healing, was never proved by his practical experience. It is a modification of this "seton method" which we have used and will describe.

The two stage operation, employing the seton, has not been used routinely in every case of fistula. A considerable proportion of fistulae are very superficial in the perianal tissues, and excision of the tract requires little removal of tissue. A small number exist as a direct tract in the midline both internal and external openings, opposite each other. For these types, excision of the fistulous tract with immediate incision of the muscle down

to the internal opening will be adequate. Almost half of the cases of fistula, however are much more extensive and in these a two stage operation is found necessary.

Of 266 patients, this operation was performed in 119. The severity of the fistulous process varied widely. Twenty-four were of the "horse-shoe type," bilateral tracts communicating either anterior or posterior to the anal canal. One patient presented 14 external openings. Sixty-two had two or more external openings. Eight gave both clinical and histological evidence of tuberculous infection. In one patient with a positive blood Wassermann, histological examination of the tissue strongly suggested a syphilitic process. In another the fistulous tract communicated with a postanal dermoid cyst.

#### OPERATIVE TECHNIQUE

The importance of definitely locating the internal opening has been pointed out previously. The injection of a solution of methylene blue (two parts) and hydrogen peroxide (one part) will identify the branches of the tract and, usually the internal opening. Occasionally this has temporarily healed over and the dye does not appear in the lumen of the anus or rectum. As the tract is dissected out of its bed, the point at which it communicates with the bowel can then be detected. Since the internal opening is most frequently in the base of an infected or torn crypt, or fissure it is advisable to explore those crypts in the portion of the anal canal which adjoins the proximal portion of the tracts. As Bile suggests, it occasionally is necessary in this approach to cut down on the crypt in order to locate the internal opening beneath it.

A grooved director is inserted into the tract through its external opening and passed as far as it can go with ease. The tissues overlying the director are incised. The director can then be made to pass further along a tortuous tract until the bowel wall is reached. The base of the fistulous tract is completely dissected out, but only as far as the bowel wall. A bed of healthy tissue is thus left to facilitate prompt healing. In like manner all the tracts are dissected away and, as a rule, they will all communicate with each other usually at a point a short distance before the main branch enters the bowel. Two or more internal openings are uncommon, but, when they do occur are treated in the same manner. A flexible probe is passed from within the anus through the internal opening into the wound and bent so as to remain in place. The proximal portion of the main tract remains, at this stage, dissected free from its bed

but still attached to the bowel wall. This is now severed from the bowel wall as close to the muscular coat as possible. The probe which has been kept in place through the internal opening is now threaded with a double strand of heavy silk and the latter drawn through the opening and out in the wound. It may be found that the direction of the tract and its internal opening has been at such an angle to the fibers of the muscle that when the muscle is cut through, the incision will not be at right angles to the fibers. If this occurs, the tissues lateral to the opening are incised to one side or the other to permit of cutting the muscles in the desired direction. The silk thread is now ready to be tied. It will be noted that the only tissues within the grasp of the ligature are the sphincter and its covering of skin and mucosa. Before tying the thin strip of skin and mucosa that would be in contact with the thread is pulled up and cut away thus exposing the muscle fibers. The silk is then tied against the muscle snugly but so as not to cause constriction. It now surrounds only the muscle, which has been left undisturbed (Fig 1).

Cutting of the muscle is reserved for a second stage. About  $1\frac{1}{4}$  inches of the ends of the thread are retained to permit of its ready identification. The wound is now packed in the usual manner. This packing is removed in 72 hours. Occasionally, only a portion is removed at this time, and the remainder on the fourth or fifth day. The wound is then dressed daily or every other day. In the after treatment which is most important care is exercised to avoid bridging of the sides of the wound and the formation of pockets. A finger passed along the base of the wound will aid in this. Subsequent packing should be carried to the depth of the wound, but inserted lightly. Frequently after 2 to 3 weeks all packing is discarded. At these dressings, the thread is grasped with the forceps and moved to and fro slightly to prevent it from adhering to the tissues in contact with it. If for any reason it is desired to change the seton this may be accomplished by tying a ligature above the knot of the seton *in situ*, cutting on the opposite side of the knot and, as the old one is drawn out, the new one is pulled into place.

The extensive dissection necessary in these operations has removed considerable tissue from the lateral and proximal (under) surfaces of the external sphincter. It has, thereby, been essentially deprived of a certain amount of its fixation. To sever the muscle at the same time would permit the cut edges of the muscle to retract and even to dip somewhat into the open wound. Since several weeks are required for the wound to fill in and heal the muscle ends become adherent to and



Fig 1. Schematic drawing showing the relation of the seton to the muscle fibers and operative wound. A. External cavity after dissection of fistulous tracts and their removal as far as bowel wall. B. Fibers of external sphincter muscle exposed. C. Heavy silk ligature, the seton, passing into anal canal, through internal opening and out into wound then tied in place to surround sphincter muscle. If internal opening is above the internal sphincter the ligature will surround both muscles.

embedded in the wound. No degree of union of the edges could be expected, and, in addition, a deep sulcus may remain in the course of the sphincter fibers. The muscle ends are fixed in a mass of scar tissue but, because of the deformity, this scar tissue often does not provide enough anchorage for the muscle to pull against and partial or even complete impairment of its function will result. The rôle of the external sphincter in maintaining anal continence has already been mentioned.

As the wound heals and the cavity fills in it will be noted that the spaces on the under and lateral surfaces of the sphincter have been replaced by scar tissue. The muscle now is well supported, probably more firmly than before operation. When the filling in process is complete, there remains only a small sinus the bed of the seton. This tract extends actually only under the muscle from its external margin. The patient is now ready for the second stage of this procedure i.e. severing the sphincter muscles (Fig 2).

The tissues immediately surrounding the ligature, as well as those encircled by it, are infiltrated with novocain in 1 per cent solution and a small curved, probe tipped grooved director is inserted through the tract from its external through its internal margin. Then the muscle fibers overlying it are severed from above downward. This enables the operator to be exact in making the incision at a right angle to the fibers. The base of the tract is gently curetted and any small bits of mucosa or



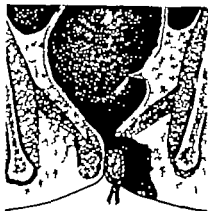


Fig. 2. Schematic drawing of a transverse section to show the relation of the seton to the tissues of the anal canal. The ligature surrounds both external and internal sphincter muscles with the internal opening of the fistulous cavity superior; the latter muscle. The mucosa and skin covering the sphincter has been incised so that ligature surrounds only the muscle fibers.

granulation tissue that overhang the wound edges are cut away. A thin strip of packing is inserted into the wound, which is usually not over a half inch deep in its greatest diameter. Because of the firm support to the muscle, the severed ends separate very slightly or they may remain practically in contact with each other. In either case, it is necessary to pass a swab to the base of the wound so that healing takes place from the bottom. Healing is complete in about 2 weeks.

The muscle ends may unite directly but, as a rule, they are joined together by a thin partition of scar tissue. Union is usually quite firm and there is little deformity in the contour of the muscle. As a result function is practically normal. By not allowing the ends of the severed muscle to remain widely separated for a period of weeks, during which these ends may become embedded in the edges of the operative wound and by delaying severance of the muscle until it is firmly supported so that its severed ends are kept in place we find that good union without deformity with good function can be achieved.

It may be claimed that this two stage procedure can be carried out as satisfactorily without the use of the silk or linen ligature the so called seton. This has not been found true in practice. The seton serves primarily to identify and to keep patent the internal opening until it is ready to be

dealt with. When not used, the mucosa may close over the internal opening as a result of the adequate drainage distal to it. Then, when the muscle is ready to be severed, the original internal orifice cannot be accurately determined. Careful dissection will then be necessary to locate it, for the importance of eradicating this focus is apparent. This closing over of the internal opening may be deceptive in that it will suggest that this portion of the fistulous tract has healed. But the small tract under the muscle will still be present and serve as a focal point for the development of another fistulous process. The seton, therefore, is of value not only in locating the internal opening for the second stage of operation, but permits this second step to be done with ease and, as pointed out, will allow us to transform the direction of the tract when occasionally necessary so that the muscle can be severed at right angles to its fibers.

#### SUMMARY

The importance of the external sphincter in maintaining anal continence is pointed out. The necessity for avoiding deformity with impairment of function of the sphincter muscles following operation for anorectal fistula is emphasized. The operative technique for a two stage operation for anorectal fistula is described in which the muscles are not severed and the internal fistulous opening not dealt with until the second stage. Good union of the muscle ends without deformity and with good sphincteric function was thereby achieved in 119 patients thus treated.

#### BIBLIOGRAPHY

1. BICKHAM, WARREN S. *Operative Surgery*. Vol. v p. 183. Philadelphia W. B. Saunders & Co. 1924.
2. BUXE, L. A. *Surg. Clin. N. America*, 1927, VII, 1570.
3. DRUCKER, CHARLES JOHN. *Fistulae of the Anus and Rectum*. Philadelphia: F. A. Davis & Co., 1927.
4. EDWARDS, F. S. *Lancet*, 1918, May 673.
5. GALT, S. G. *Diseases of the Rectum, Anus, and Colon*. Vol. I, p. 332. Philadelphia: W. B. Saunders & Co. 1923.
6. HILLER, R. J. *Surg., Gynec. & Obst.*, 1931, XL, 921.
7. HILSCHMANN, LOUIS J. *Handbook of Diseases of the Rectum*. St. Louis: C. V. Mosby Co. 1923.
8. MATTEI, HERMANN. Quoted by Hiller. *Deutsche Ztschr. f. Chir.* 1909, 4, 70.
9. MARTIN, COLLIER F. *Am. J. Surg.* 1925, December.
10. PRITCHARD, J. R. *Rectum, Anus and Pelvic Colon*. P. 619. Philadelphia: P. Blakiston & Co. 1925.
11. SUTTER, W. E. *New Orleans M. & S. J.* 1923, LXII, 515.

## DIAGNOSIS AND TREATMENT OF CIRCULATORY DISTURBANCES OF THE EXTREMITIES<sup>1</sup>

GEZA DE TAKATS M.D., M.S., F.A.C.S. AND WALLACE D. MACKENZIE, CL.B. M.D., CHICAGO

**P**ROGRESS in the field of peripheral vascular diseases can be expected only when adequate methods for testing peripheral circulation are systematically employed and when the value of various therapeutic procedures can be estimated not only by the subjective and often suggested impressions of the patient but by objective functional tests. It is the purpose of this paper to give an outline of such methods of examination and treatment that have proved to be of value, without attempting to cover the extensive and often confusing literature on the subject. The material up to date consists of 100 cases of proved peripheral vascular disease and does not include a great number of examinations on patients in whom peripheral circulatory disturbance was suspected but not detected.

### OUTLINE OF EXAMINATION

When a patient's complaints such as cold hands and feet, pale cyanotic or hyperemic extremities, tingling and numbness of the acra, burning and freezing cramping on walking or at night, suggest a circulatory disturbance, a systematic investigation of the peripheral vascular status is indicated.

The peripheral pulse is estimated on the basis of three. It is palpated at the dorsum of the foot, at the inner ankle in the popliteal fossa and below Poupert's ligament in the lower extremity. In the upper extremity, the digital pulses—those of the radial, ulnar, and cubital arteries and finally the subclavian artery are sought. A difference of symmetrical pulses is significant and may mean an aneurysm, an arteriovenous fistula or a partial or total vascular occlusion in the periphery. Absence of pulse may be present immediately after a severe injury to a limb but does not necessarily mean injury or thrombosis of the main artery. Such segmental spasms of large vessels, chiefly the femoral have been described by Kuettner. One of us has seen several cases in the World War on the Serbian front. The spasm is relieved by heat within a few hours and the cold pallid limb may regain its normal appearance.

Absence of pedal pulses is not infrequently present in older patients, overwhelmingly men who suffer from peripheral arteriosclerosis. Such patients may have no complaints at all and their

feet are warm. Adequate collateral circulation had developed during a slow gradual occlusion of the main vessel. From a standpoint of function their peripheral circulation is compensated. An absence of pulse does not necessarily mean that no blood is carried in that vessel, as a rigid, calcified vessel, unable to transmit a pulse wave may still permit an even trickling of blood to the periphery.

The surface temperature is estimated at various levels of the limb either with a thermocouple galvanometer or with a mercury skin thermometer. The latter is sufficient for practical purposes. Absolute values are meaningless as so much depends on room temperature, amount of perspiration and outside temperature. Measurements should be taken if possible, in a room not warmer than 22 degrees Celsius (70 degrees Fahrenheit) as otherwise the warm room will simply transmit its temperature to a cold extremity. Excessive perspiration a frequent sign of increased sympathetic irritation lowers temperature by increased loss of heat. The value of skin temperature readings is limited to (1) sudden drop in temperature of one extremity as a sign of inadequate arterial inflow. This can be well estimated with the palm of the hand which easily detects differences larger than  $\frac{1}{2}$  degree centigrade (2) marked differences between the temperature of symmetrical areas on two extremities, (3) a rise in temperature after various diagnostic measures, which aim to relieve vaso-constriction such as typhoid vaccine and novocain block.

Postural changes of color. Dependent rubor and pallor on elevation, furthermore pallor on exercising the elevated foot (18) are a sign of diminished arterial inflow to the capillary bed. Older patients however may have a dependent rubor on standing without any serious disturbance of circulation.

The cutaneous histamine reaction. One of us evaluated this method elsewhere (6). When histamine acid phosphate is injected intradermally not more than 0.1 c.c. being used at a time a characteristic vasodilation occurs around the wheal the arterial flare. The flare is due to a reflex vasodilation of the arterioles and is absent when (1) there is not enough pressure in the skin vessels to fill up the dilated arterioles

<sup>1</sup> From the Peripheral Circulatory Clinic, Department of Surgery Northwestern University Medical School.

(2) when an arterial spasm exists, which the histamine cannot overcome, or (3) when the cutaneous nerves have degenerated following peripheral nerve injury. Introduced as a routine measure in patients with manifest or suspected peripheral vascular disease the test gives the following information:

1. In patients with frank gangrene the lowest level of safe amputation is determined although a normal histamine response only guarantees the status of cutaneous circulation. Circulation of bone may be impaired at the same level.

2. The improvement or standstill of the peripheral circulatory status can be determined during the course of conservative treatment.

3. In a beginning embarrassment of arterial inflow the delay or absence of the histamine reaction around the ankle gives an early warning.

4. In vascular spasms the reaction is negative, but such reactions may be made positive by any measure that is known to relieve vessel spasm. These will be discussed a little later.

*The oscillometer.* Puchon's oscillometer when the readings are charted according to our method (Fig. 1) determines the narrowing or occlusion of the main vessels. The shape and height of the curve determined at different levels of the same extremity and compared with readings at symmetrical levels of the other extremity gives an exact picture of arterial inflow through the larger arteries. Readings taken above and below aneurysms or above and below arterial occlusions demonstrate the amount of inflow and the site of the lesion. Contrary to the histamine test, the oscillometer does not determine the extent of collateral circulation.

*Röntgenological examination.* Flat plates reveal calcification of peripheral vessels, the extent of which is sometimes surprising compared with the lack of clinical signs and symptoms. The chief enemy of the adult diabetic, arteriosclerosis, can be demonstrated early in juvenile diabetics (21). But such findings do not determine the adequacy of circulation and can be used only as an adjunct in determining the peripheral vascular status. Much more information can be gained by visualizing blood vessels after the injection of opaque substances such as Iopax, skiodan, or thorotrast (Fig. 2). In our work the first two substances have been used. The indications should be limited (1) to aneurysms, both traumatic and congenital, when the size of the sack, the site and number of communications and the development of collateral circulation can be visualized and helps to outline the plan of operation (2) to patients with marked organic ob-

struction as in certain stages of Buerger's disease, when the idea of sympathectomy might have to be abandoned because of the extent of organic vascular stenosis (3) to cases of peripheral embolism, to determine the exact site of the embolus, if otherwise undetermined.

*Examinations not routinely employed* but which may prove to be very valuable in certain patients are:

1. Electrocardiogram, which is taken before every sympathectomy.

2. Blood volume and blood viscosity when polycythemia is suspected. Blood volume may differentiate between an early polycythemia and Buerger's disease. In the latter the blood volume is below normal.

3. Ophthalmoscopy. The status of retinal vessels may give a valuable indication as to the status of the peripheral vascular system.

4. Plethysmograph, constructed by Johnson, which may prove of great value in clinical research problems.

5. Biopsies of smaller arteries of the hand and foot which may reveal characteristic histological changes.

#### DIFFERENTIATION OF ORGANIC AND SPASTIC VASCULAR OCCLUSIONS

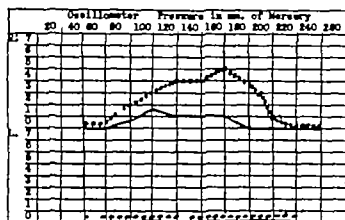
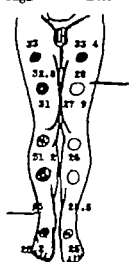
In a previous paper (7) the various methods employed were discussed and we will present only the ones actually employed now in our work. As it is known that the vasoconstrictor fibers to an extremity run in the peripheral nerves, a novocain block of these nerves will release the arterial tree from all central vasomotor influence. In the lower extremity the posterior tibial nerve is blocked at the inner ankle and the skin temperature of the plantar surface of the big toe is determined before and 10 minutes after the injection. Table I taken from a previous communication, illustrates the figures which may be obtained and their interpretation. In painful, vasospastic amputation stumps, the femoral or sciatic nerves have been successfully blocked. On the upper extremity according to the involved areas, the ulnar, the median nerve, or the brachial plexus have been blocked and the increase in surface temperature to the normal vasodilation level of 33-35 centigrade was determined.

As most of our patients are ambulatory tests with typhoid vaccine, spinal or paravertebral anesthesia have not been employed. Besides, these methods are open to criticism.

The use of vasodilator drugs such as theobromin, aminotrite and acetylcholine as a therapeutic test is well established but does not give such

## PERIPHERAL CIRCULATORY RECORD

Name Mrs. G. K.	Age 63	Diagnosis Diabetic gangrene
Skin temperature	Sudden drop at upper third of left thigh	Blood pressure 160/90
Pulse	Right Left	Blood volume —
Popliteal	1 0	Blood count —
Post tibial	0 0	Blood viscosity —
Dorsalis pedis	1 0	
Histamine test	Right Left	
On basis of 0 to 3		
Above knee.	3 0	
Below knee	2 0	
Middle of calf.	2 0	
Ankle	1 0	

Other findings  
Right Left

Temperature of left big toe  
Before novocain block 35 C  
After novocain block 36.3 C  
Obstruction index  $33 - 36.3 = 6.8$

— Below knee  
---- Above knee

Room temperature 25 C.

Résumé Organic vascular obstruction with hardly any superimposed spasm. Skin temperatures and histamine flares indicate level of amputation on left at upper third of thigh. Right leg painless but is in danger of future gangrene.

Fig. 1 Record used in the Peripheral Circulatory Clinic, Northwestern University Medical School. Blood volume, blood counts and blood viscosity are determined in cases suspicious of polycythemia. A majority of patients, afflicted with Buerger's disease, have high red counts, high viscosity of the blood and low blood volume. Pulse and histamine reaction are estimated on the basis of three. The oscillometric readings are plotted on a graph and give much more information than the customary oscillometric index. The graph indicates the size of oscillations (vertical figures) plotted against the pressures in the upper cuff of the instrument, expressed in millimeters of mercury. In this patient, the oscillometric curve is fairly normal at the right thigh, very flat at the right ankle. No oscillations are present on the left leg, both below and above the knee. The skin temperature is expressed in centigrades, and measured with a mercury skin thermometer. The histamine flares are drawn in 3 degrees of intensity marked, diminished, and absent. The temperature of the left big toe rose very slightly after the injection of 5 cubic centimeters of a per cent solution of procaine hydrochloride into the posterior tibial nerve. The maximum rise in temperature deducted from the normal vasodilation level of 33 C. (Morton and Scott), gives a high obstruction index of 6.8. The graph illustrates the method of determining the peripheral vascular status on an ambulatory patient.

an accurate idea of the spastic element as the nerve block. The effect of heat on oscillometric readings or histamine response is another possible approach to the problem which we have occasionally employed.

## DETERMINATION OF THE PROPER LEVEL OF AMPUTATION

It is not within the scope of this paper to discuss the indications for amputation. Instead we wish to emphasize our methods for arriving at a deci-

TABLE I.—DIAGNOSTIC VALUE OF POSTERIOR TIBIAL BLOCK

	Number of cases	A. average rise in temperature	Average electric foot index
Group I		7 C	None
Group II	12	5 C	2
Group III	16	C	1

Group I—Patients with cold feet, good pulses, pers. sparse, no electric foot.

Group II—Patients with organic occlusions, no, or hardly any, superimposed spasm.

Group III—Patients with organic occlusions and considerable spasm.

Obstruction index (Morton)—normal vasodilation level (17° C)—normal temperature obtained after nerve block.

The use of peripheral nerve block for differentiating spastic from organic occlusions. Occasionally when marked spasm occurs above the level of nerve block, the vasodilation below the injection will not represent maximal vasodilation. In such patients nerve blocks have to be performed at a higher level.

son as to the site of amputation. There has been much confusion and uncertainty on this point.

When an amputation is decided on, we systematically employ the tests described, the pulses are palpated, surface temperatures are read, the oscillogram and histamine reaction are employed. Most useful are the surface temperatures and the histamine reaction, the results of which coincide most often (Fig. 1). Oscillogram readings would generally indicate a higher occlusion of the main vessel but this is easily explained by the development of a sufficient collateral circulation distal to the occlusion. Thus, for instance, in mid thigh amputations the femoral pulse is often absent, the oscillogram readings are zero at the upper third of the thigh, but the skin temperature readings and the histamine response clearly indicate a sudden change in circulation at a certain level on the thigh.

A negative histamine flare is mainly useful in insuring us against too low amputations, while a positive flare may not insure us of enough circulation to take care of the healing of the stump. One must also know that circulation in the bone not subjected to the beneficial action of muscular massage is often impaired at a somewhat higher level, as proved by injected specimens (4).

In spite of the fact that we have amputated just as low as possible with the help of these tests not one single reamputation was necessary during the last 3 years. Another interesting fact was the frequent finding of infectious gangrenes due to osteomyelitis of the toes in diabetics, as first stressed by McKittrick and Root. These patients do not require an amputation at all, as the gangrene is not on a circulatory basis, and con-

TABLE II.—CLASSIFICATION OF PERIPHERAL VASCULAR SYNDROMES

A. Organic lesions		B. Functional disturbances	
Congenital anomalies	12	Vascular spasm	24
Ischemia		Primary idiopathic (Raynaud)	3
Thrombotic, arteritis, thrombosis	3	Secondary arterial	
Thrombotic frost bite	4	Taken, erythromyalgia, spastic hemorrhage and phlebotomy	
Chemical, lead, arsenic		Cervical rib	
Electrical		Obstruction of spine	
Radon and X-ray		Spinal inflexion	
Ischemia	27	Thrombotic arteritis	
Thrombotic-arteritis obliterans (Buerger)	20	Polymyositis	
Rheumatic infection	3	Amputation-syndrome	3
Low		Minorsky's spastic syndrome	
Tuberculosis		Early interstitial hypotension	3
Paratyphoid	7	Etiologic disturbances	
Degenerative processes	3	All organic changes with superimposed spasm	5
Peripheral arteriosclerosis			
Diabetic endarteritis			
Emboli of infarction			
Very reactions			
Total	66		

C. Vascular spasm	
Erythromyalgia	4
Polymyositis	—
Compensatory hypertrophy	—
Atrophia	3
Total	11

servative treatment, with minor amputations is often successful.

#### CLASSIFICATION OF PERIPHERAL VASCULAR SYNDROMES

Table III gives a working classification of these disorders. Obviously with increased knowledge on the subject, certain essential, "primary" lesions will be grouped with the syndromes of known etiology. It must be also emphasized that organic lesions will almost invariably produce superimposed functional disturbances and that vessel spasm, if repeated too often, will undoubtedly bring about organic changes. With the help of the tests described it is possible to differentiate the organic from the spastic element.

1. *Organic lesions* The first group of organic lesions, the congenital anomalies, have been studied and described in detail (8). Our material now consists of 12 cases. Early recognition and radical surgery offer the best hope for cure. In most cases, there are abnormal arteriovenous communications, which are too narrow to give any thrill. Early recognition depends on (1) increased surface temperature of the affected side (2) hemihypertrophy of the affected limb (not always present) (3) the presence of mixed (arteriovenous) blood in the vascular dilatations, which may be recognized by the color of the blood or exactly by determinations of oxygen content with the Van Slyke apparatus. The visualization of blood vessels of the affected side may lead the

TABLE III.—VASCULAR ANOMALIES (12 CASES)

Case	Age Sex	Diagnosis	Duration	Symptoms	Treatment	Result
17014 Ev. Hos.	25 F	Multiple arteriovenous fistulae of hand	Noticed since age of 12	Swelling, dilated veins, pain in arm and hand, hand eczema	Excision of vascular mass	++++ Hand useful
H. L.	21 M.	Phlebectasia of wrist and forearm	Noticed at age of 13	Progressive dilatation of veins at wrist, dull ache on exercise	Excision of anomalous vessels	++++
J. de F.	20 M.	Hemangioma of right half of scrotum, buttocks, thigh and calf	Noticed at age of 5	Progressive dilatation of vascular masses; swelling, pain, cyanosis	Excision and obliterative injections	+++ There are a few remaining dilatations, function normal
A. D.	16 F	Congenital vascular anomaly of left leg—large birthmark	Noticed at age of 10	Swelling, repeated hemorrhage from millary aneurisms	Excision in three stages and obliterative injections	+++ Some residual cyanosis of toes
M. L.	43 F	Vascular anomaly left popliteal fossa	Ever since she can remember	Multiple spongy, vascular masses pain swelling	Complete excision	++++
H. Z.	15 F	Congenital vascular anomaly of face and orbit	Since birth	Progressive vascular dilatation, intermittent exophthalmos	Refused operation, radium treatment elsewhere	Unknown
W. E. L.	14 F	Congenital vascular anomaly of left foot, calf and buttocks	Since birth	Intermittent claudication recurring phlebitis progressive dilatation	Obliterative injections	Pain subsided, anatomic result +, functional result +++
L. B. D.	11 M.	Congenital arteriovenous aneurism, right leg	Noticed at age of 10	Ulcer, huge indurative edema, Right leg larger than left	Excision of aneurism	Anatomic result +, functional result ++++
A. A.	10 F	Multiple angiomas of lips and tongue	1 year?	Swelling, bleeding, gradual spread	Multiple obliterative injections	++++
L. de B.	12 F	Phlebectasia of superficial veins of neck	?	Spontaneous thrombosis capillary dilatation	Excision	++ Some recurrence of vascular dilatations
C. R.	11 M.	Multiple arteriovenous fistulae of left leg	Since birth	Elephantiasis, dilated vessels, cyanotic toes	Excision followed by injections	+++ Some residual swelling
A. C.	25 F	Arteriovenous fistula left foot	? possibly started with trauma	Swelling, increased temperature, ulcer on dorsum of foot, venous pulsation	Excision of arteriovenous fistula	++++

surgeon to a direct attack of the anomalous communications. Radical excision may be supplemented, if necessary, with obliterative injections.

In the second group, the word *injury* has been used in a more general sense. Frost bite even though the initial injury may seem to localize only in one finger or toe, frequently produces endothelial changes in the vessels proximally to the acra. Thus, patients' extremities, if amputation becomes necessary, are removed far too low, and several reamputations are usually made before the adequate level is reached. Histologically, cushions of cellular masses, a true granulation tissue, accumulate below the endothelium produce damage of vessel permeability and are responsible for all other changes such as medial oedema, perivascular reaction, thrombosis and perineuritis (10, 11). This vascular reaction is the typical response of the vessel wall to all other forms of injury, electric, chemical, bacterial or allergic, and it is for this reason that the histological picture of Buerger's disease is so similar to that of frost bite. That these organic changes can again produce reflex vascular disturbances is

most likely and thus a vicious circle is established.

Burns, but particularly electric discharges, may produce vascular damage which is hardly estimable at the time of injury. Thus an electric current may simply roll up the intima of a large vessel and produce thrombosis at a distance. A repair man on an elevated line, who received repeated electric shocks and in addition, worked in extremely cold weather without gloves showed a marked obliterative endarteritis of the fingers.

Vascular damage due to lead or arsenic is not well known, but does occur since moonshine liquor frequently contains both metals. Our material contains 4 cases of this sort.

We shall skip the discussion of traumatic thromboses, aneurisms and pressure necrosis, as little of new data has accumulated on the subject. Blood vessel visualization, however, has added a great deal to the rapidity and ease with which these formidable surgical problems can be attacked. The amount of collateral circulation following compression of the proximal feeding vessel, must be studied before a permanent arterial ligature is undertaken.

TABLE IV—VASCULAR INJURIES (11 CASES)

Case	Age Sex	Diagnosis	Duration	Symptoms	Treatment	Result
11969	34 M.	Arteriovenous aneurism, mid thigh	6 weeks	Swelling, brist, venous pulsation	Endo-arteriovenous anastomosis	+++ Slight swelling and cyanosis
12691	40 F.	Thrombosis of iliac artery following venous thrombosis	5 years	Diminished pulse, temperature, pain, claudication	Physiotherapy; elastic support; salicylates and sedatives	++
H. H.	35 F.	Thrombosis of femoral artery following deep venous thrombosis	3 years	Pedal pulse absent, dependent rubor, left leg swollen, cold	Physiotherapy; camphorated chloral and salicylate	+ Swelling improved, no improvement of arterial circulation
12614	32 M.	Frost fingers, left hand	years	Blackening stiff joints, diminished pulse	Physiotherapy	+ Slow improvement
H. F.	45 M.	Frost fingers and toes	days	Swelling, blisters, absent digital pulsations	Constriction; heat; protective dressing	Amputation of two fingers
14166	28 M.	Frost bite. Bilateral amputations 2 inches below knee	5 years	Cold stump; decubital ulcers, claudication	Bilateral lumbar sympathectomy	Left stump — Right stump +++
C. S. W.	61 M.	Obliterating endarteritis. 8 mg. lead in 24 hour urine	4 years	Pain, color changes, numbness and tingling	Stopped alcohol, Asa's diet	No improvement. Died one year later of coronary thrombosis
44128	37 M.	Vascular spasm; lower extremities; prolonged exposure to lead		Sudden drop of temperature at knees; tingling, numbness, weakness	Asa's diet; physiotherapy	+++ Almost completely relieved, very little permanent damage
50227	22 M.	Vascular spasm; chronic lead poisoning		Numbness and tingling of symmetrical areas; hands generally warm	Elimination of exposure to lead	+++
W. P. L.	43 M.	Vascular spasm; 5 mg. arsenic in one cm. of urine	6 months	Spasm in calves, numbness and tingling	Eliminated arsenic; continued Asa's diet; vasodilators	+++ Practically free of symptoms
H. W.	41 M.	Repeated electric shocks, exposure to cold; excessive smoking. Rapid rise on elevated limb	year	All fingers except thumb numb and painful, sensitive to cold	Physiotherapy and vasodilators	Could not be followed

\*Results graded on the basis: — to +++

The third group of *inflammatory* vascular reactions is a most difficult subject. It has already been stated that the vessel wall always responds with the same type of reaction no matter what the original injury is. We have observed peripheral vascular disturbances due to syphilis, paratyphoid, rheumatic fever and a very rare case of tuberculous arteritis in a colored girl arteritis has been described in typhus fever, cholera, bacterial endocarditis, and streptococcus septicemia. It is very probable that thrombo-angitis obliterans, justly called Buerger's disease, will be gradually split up into diseases of known etiology and with it specific treatment will become possible. The rôle of ergot in producing peripheral vascular disease has also been re-emphasized (14). Any attempt to classify and separate these inflammatory arteritic reactions on a histological basis is of doubtful value as specimens gained at amputations or seldom through biopsy contain the vessels in a terminal stage of thrombosis, obliteration, and partial recanalization. Nevertheless, biopsies of smaller arteries often

yield conclusive evidence of the specific nature of an arteritis. The endothelial proliferation, whether the infectious agent comes from the adventitia or from the blood stream, seems always the most important reaction. That some of these recurrent attacks of arteritis and phlebitis are on an allergic basis is very likely as the small adventitial and subintimal patches of fibrinoid degeneration and granuloma have all the earmarks of hyperergic inflammation (12). Many of the so called cases of Buerger's disease may be rheumatic in nature. It has been our impression that vascular inflammatory reactions are usually seen in patients with hypoplastic vessels, lymphatics, atherosclerosis.

In the fourth group of degenerative processes belong the senile arteriosclerotic and diabetic gangrenes and pregangrenous states. Most pathologists agree on a separation of atherosclerosis, intimal plaques from the types in which medial calcification is the primary lesion. The development of adequate collateral circulation will depend on sufficient cardiac reserve and collateral vessels capable of dilatation. A differ-

TABLE V—INFLAMMATORY REACTIONS (26 CASES)

Case	Age Sex	Diagnosis	Symptoms	Treatment	Result
40473	26 M	Buerger's disease	Pain on walking and rest, dependent rubor absent pulses	Typhoid vaccine, stop smoking, vasodilators physiotherapy	Improving under treatment
1735	41 M	Buerger's disease	Cold fingers and toes, ulcer on left index finger weak pulses	Typhoid vaccine vasodilators, physiotherapy	++ Ulcer healed skin still glossy cold in quiescent stage
53047	40 M	Buerger's disease	Arrest of circulation, both feet very ill the spaces blood volume low	Typhoid vaccine postural exercise diathermy push fluids	+ Heavy drinker could not be followed
35653	40 M	Buerger's disease	Intermittent claudication, color changes, tenderness of calves great deal of spasm	Typhoid vaccine. Physiotherapy, continuous baking at night	++ Marked improvement discontinued treatment
43332	31 M	Buerger's disease	Numbness and aching right index finger small ulcer	Typhoid vaccine continuous heat stop smoking	++++ Ulcer healed pain disappeared no digital pulse
72144	30 F	Buerger's disease	Numbness, pain, ulcer on medial aspect of tibia spontaneous phlebitis	Rest, elevation, tonillaceous (cont) warm baking	Did not return for follow-up
36441	27 F	Buerger's disease	Intermittent claudication foot cold pulse weak, no sclerosis	Vaccine physiotherapy vasodilators	++ Still under treatment
55962	30 M	Buerger's disease	Sudden drop of temperature at mid thigh intermittent claudication	Physiotherapy vasodilators	++ Amputation of two toes
15486 + F	41 M	Buerger's disease	Dependent rubor ulcer left big toe rest pain	Vaccine vasodilators physiotherapy	No improvement; patient could not be followed
E. A.	31 M	Buerger's disease	Lost both legs below knees pain numbness to hands	Gravol (dial) previous treatment; left cervicothoracic sympathectomy	Left side warm, painless right exchanged
K. G.	31 M	Buerger's disease	Dependent rubor; great deal of spasm relieved by nerve block	Lumbar sympathectomy	Feet still cyanotic but pain less, hands are grilling involved
E. H.	32 M	Buerger's disease	Both legs previously amputated, sudden drop of temperature left wrist, ulnar second finger	Continuous heat in bed vaccines, vasodilators	++ Marked improvement ulcer healed
J. M.	49 M	Buerger's disease, beginning arteriosclerosis	Rest pain, sensitive to cold	Vasodilators physiotherapy	Did not return vaccine was not given
C. F.	30 M	Buerger's disease	Intermittent claudication, rest pain, poor pedal pulses	Vaccine, physiotherapy, vasodilators	++++ Patient perfectly symptomless for three years
T. G.	30 M	Buerger's disease; peripheral arteriosclerosis	Intermittent claudication, cold and numb toes	Physiotherapy vasodilators	+ Slight improvement
N. G.	30 M	Buerger's disease	Rest pain no pedal pulses	Stop smoking vaccine, physiotherapy	Could not be followed
J. F.	41 M	Buerger's disease	Dependent rubor phlebotic patches cold pulseless foot	Physiotherapy vaccine vasodilators	++ Marked improvement, one year; few flare-ups in winter
G. D.	41 M	Buerger's disease	Two toes amputated, rest pain phlebotic patches	Vaccine vasodilators physiotherapy	Not seen since last visit
M. V. Th.	38 M	Buerger's disease	Pain in soles of feet big toe ulcerated	Rest in bed three weeks, physiotherapy and vaccines	+++ Ulcer healed pain subsided
E. V.	30 F	Rheumatic heart; rheumatic arthritis	Cold, pulseless foot, indolent leg ulcer	Salicylate vaccine physiotherapy	Still under treatment
A. E.	45 F	Rheumatoid arthritis in hands and feet; rheumatic arthritis	Pulseless foot dependent rubor claudication	Vaccine, physiotherapy	+ Slight improvement in collateral circulation
A. H.	42 F	Leukic arthritis leukic heart	Claustration; rest pain, dependent rubor	Antibiotic treatment, physiotherapy	Still under treatment
43105	31 M	Leukic ulcer of leg; arterial obstruction	Foot pulseless, cold claudication	Antibiotic treatment, physiotherapy	++ Ulcer healed, leg still pale
M. N.	31 M	Paratyphoid fever followed by popliteal hematoma positive culture	No pedal pulse dependent rubor claudication	Antigenous vaccine physiotherapy	+++ Greatly improved
A. J.	18 F	Pulmonary and joint tuberculosis; obliterating arteritis left big toe with self amputation	Sudden drop in temperature at midcalf absent pulses	Rest in bed three weeks, physiotherapy and vaccines	+++ Ulcer healed pain subsided
34441	30 F	Buerger's disease?	Claustration in left foot. Posterior tibial artery weak; skin glossy	Vaccine, physiotherapy vasodilators	Not improved
35043	30 M	Leukic arthritis ulceration	Absent pulses on foot; large punched out ulcer	Antibiotic treatment	Ulcer healed. Arterial obstruction not improved



TABLE VI—DEGENERATIVE PROCESSES (17 CASES)

Case	Age Sex	Diagnosis	Symptoms	Treatment	Result
Dr. E. R.	57 M.	Peripheral arteriosclerosis unimpeding gangrene	Color changes, sudden fall in temperature, rest pain	Digital sympathectomy physiotherapy vasodilators	+ Slight improvement of circulation
15157 + E	64 M.	Arteriosclerotic gangrene	Ulcers on left heel and external malleolus	Amputation advised	
15158	51 M.	Arteriosclerotic endarteritis	Cramps on calves, absent radial pulses, color changes	Physiotherapy vasodilators	++ Much improved
46076	60 M.	Peripheral arteriosclerosis by perforation	Left leg trophic, cold, pulseless	Physiotherapy vasodilators	+ Subjective improvement
151764 +	71 M.	Calcified vessels hyperlipemia	No pulses below knee, toes warm, slight claudication	Physiotherapy vasodilators	Good collateral circulation
151780 + E	48 M.	Peripheral arteriosclerosis	Numbness and tingling in toes, intermittent claudication	Did not return	
151877 +	62 M.	Peripheral arteriosclerosis myocardial degeneration	Sudden drop in surface temperature absent pedal pulses, scaly atrophic skin	Digital sympathectomy physiotherapy	+ Slight improvement
36142	70 M.	Hemiplegia six months before by peroneous, unimpeding gangrene	Cold, cyanotic feet, rest pain	Amputation above knee	+++ Useful stump
35000	57 M.	Peripheral arteriosclerosis, by perforation	Intermittent claudication; absent dorsalis pedis pulses	Physiotherapy vasodilators	Did not continue treatment
494	61 M.	Impending arteriosclerotic gangrene	Pain, cyanosis, drop in temperature	Vals injection advised	Refused treatment
Ch. P.	67 M.	Peripheral arteriosclerosis, by perforation	Drop in temperature, claudication, rest pain	Physiotherapy vasodilators	Did not return
49446	56 M.	Peripheral arteriosclerosis	Claudication, numb, cold feet	Physiotherapy vasodilators	++ Much improved
11 J. W.	72 M.	Peripheral arteriosclerosis	Claudication, no rest pain	Digital sympathectomy physiotherapy vasodilators	+ Slight improvement
B. A. D.	7 M.	Obliterating endarteritis	Pulses good, no rest pain	Physiotherapy	+++ Marked improvement
54	4 M.	Peripheral arteriosclerosis high grade endarteritis	Two gangrenous spots, swelling, cyanosis, cold cramps	Previously amputated physiotherapy injection of aneurin	+ Some improvement, left the city
J. M. D.	51	Prostatic hypertrophy hyperlipemia peripheral arteriosclerosis	Pedal pulses absent; necrotic patch at heel, cold toes	Alcohol injections left foot	Foot gangrenous for 3 months; gangrene, amputation
A. H.	7	Diabetic endarteritis	No pulses below popliteal, marked rest pain	Radical amputation at mid thigh	Lived 4 months died of coronary thrombosis
11 P.	56 M.	Diabetic endarteritis	Good pulses. Two gangrenous ulcers on foot	Rest in bed, physiotherapy; Thiersch grafts	Grafts took; leg amputable in protective cast

uation of these degenerative processes from late stages of inflammatory reaction with scar formation is not always possible particularly in older patients. From the standpoint of prognosis and treatment however the important point is whether the vascular obstruction is chiefly organic and irreparable or whether superimposed spasms are present, which may be relieved.

An important distinction must be made in the diabetic group between gangrenous states that are primarily due to obstruction of the larger vessels, and gangrenes due to infections usually osteomyelitis of the toes. While the former group requires major amputations, the latter should be treated by incisions and wide drainage or minor amputations. Because of the frequent inflam-

matory reactions in diabetic tissue, surface temperature readings may be misleading. The histamine reaction is most useful to determine the level of circulatory insufficiency.

**B Functional disturbances (1) Vascular spasms.** The diagnosis of Raynaud's disease, a pure spastic occlusion of the digital arteries with unknown etiology should be made only when all secondary vascular spasms can be excluded. This is important not only because the removal of the primary factor may bring about a dramatic cure, but also because major operations on the sympathetic nervous system are unnecessary and do not result in cure in the secondary forms.

The transection of the scalenus anticus muscle in patients with cervical rib (1) the freeing up of

TABLE VII.—VASCULAR SPASMS (RAYNAUD'S SYNDROME)—(26 CASES)

Case	Age Sex	Diagnosis	Symptoms	Treatment	Result
43909	21 F	Idiopathic vascular spasm	Intermittent blanching: numbness of fingers	Physiotherapy: cold training	No attack for 6 months
47124	29 F	Vascular spasm: cutis marmorata	Hyperensitive to cold and mechanical stimuli	Physiotherapy: cold training	+++ Markedly improved
M. K.	26 F	Migraine headaches, vascular spasm in feet and hands	Tingling and numbness, chiefly in third finger of both hands	Isoline, amyl nitrite	No change
A. McD	21 F	Idiopathic asymmetrical vascular spasm, all four extremities	Pain, coldness, terminal ulcerations, trophic changes	Lumbar sympathectomy advised	Did not return for operation
T. N.	2 M	Spastic occlusion; scleroderma	Terminal symmetrical ulcers: discolored skin	Unilateral cervicodorsal sympathectomy	Vascular symptoms and pain improved: scleroderma unchanged
R. P.	8 F	Spastic occlusion of fingers and toes; rheumatoid arthritis	Coldness, tingling, blanching: swollen, clammy hands	Physiotherapy: vaccines	+++ Improved
C. Sp.	45 F	Osteoarthritis cervical spine; vascular spasm in fingers	Numbness, pitting, tingling of fingers: sensitive to cold	Physiotherapy: vaccines	Did not return for treatment
43760	30 F	Vascular spasm in fingers: bilateral cervical rib	Tingling and numbness in fingers, sensitive to cold	Operation advised	Did not return for operation
A. J.	12 F	Anterior poliomyelitis, unilateral vessel spasm	Cyanotic, cold extremity	Sympathectomy advised	Did not return for operation
26922	13 F	Spastic hemiplegia, marked vascular spasm, total contracture	Pain, coldness, tingling: trophic ulcer at heel	Lumbar sympathectomy	Ulcer did not stay healed: amputation
2406 +	21 M.	Spastic occlusion both lower extremities: chiefly left, spina lumbococcygea	Pallor of left foot, coldness, numbness: abnormal flushing of right foot	Exposure of spina lumbococcygea advised	Not operated on
5354	18 M	Vascular spasm, spina lumbococcygea (first sacral segment)	Intermittent claudication, increased perspiration	Lumbar diathermy	+++ Marked improvement
47590 +	20 M	Amputation neuroma, foot crushed 8 years ago	Cold, painful stump: trophic ulcer on aspectum	Physiotherapy: operation advised	+++ Pain relieved, stump still cold
J. O.	45 M.	Amputation of left foot for crushing injury; amputation neuroma	Cold, painful stump: throbbing at night	Neuroma injected with alcohol	+++ Rather lasting over 6 months
H. F.	28 M	Amputation left lower leg for injury; marked vascular spasm to knee; amputation neuroma	Cyanotic, cold stump, which warms up after novocain block	Excision of neuroma advised	Amputated at Cook County Hospital, neuroma verified
V. B.	20 F	Soft tissue injury to forearm, traumatic peroneuritis of median nerve: secondary vessel spasm	Glucose cold fingers: sensitive to cold: novocain abolishes all spasm	Physiotherapy	+++ Steady improvement
51521	28 F	Vascular spasm: lower extremities: frostbite; endocrine disturbance	Attacks of blocking followed by cyanosis; early anemias: basal metabolism rate -20 per cent	Thyroid extract, gr. later gr. li	+++ Circulation markedly improved, no further attacks of spasm
51520	44 F	Vascular spasm, endocrine disturbance	Pain in calves and ankles; left leg much colder: basal metabolism rate -8 per cent, precocious symptoms	Thyroid, gr. li	+++ N further spasm: toes warm
5038 +	29 F	Vascular spasm: pitting oedema to knees, endocrine (pituitary?)	Cyanotic, coldness: legs, increased blood volume: normal basal metabolism rate: normal sed. rate	Ammonium chloride as tyrgan	+++ Oedema temporarily improved, general condition like same
50908 +	14 F	Vascular spasm; endocrine disturbance	Anaesthesia 8 months: cold, cyanotic extremities: basal metabolism rate -14.8 per cent	Thyroid, gr. li	+++ Greatly improved
54815	7 F	Vascular spasm; parathyroid disturbance?	Cyanosis fingers and toes, basal metabolism rate and blood sugar normal: blood calcium 11.8 mgm. decalcified bones in hand		
51290	2 M	Vascular spasm; polyneuritis; vitamin deficiency?; starvation	Cold, vasospastic extremities, tingling, cramping	Balanced diet	Did not return
S. W. D.	42 M	Vascular spasm; early hypertension	Cold extremities, spasm in calves: pain at night	Vasodilators	Not seen again
G. G.	62 M	Vascular spasm, anginal attacks, hypertension	Burning and pain in calves and feet	Vasodilators, sedatives: physiotherapy	+
E. A.	41 M	Vessel spasm, spastic hypertension	Leg feels heavy and numb: cramp in calves	Physiotherapy: vasodilators, vacation	Unable to relax: no improvement
C. S.	41 M	Sacroccutaneous spastic syndrome	Vessel spasm of left fingers—only in winter	Physiotherapy: cold training; no work with ab-lanner	Not re-examined

TABLE VIII.—VASOPARALYTIC PHENOMENA (6 CASES)

Case	Age Sex	Diagnosis	Symptoms	Treatment	Result
12036+	27 M	Polycythemia vera, hypertension	Pain, rubber claudication, burning, increased blood volume, increased viscosity	Phenyhydrazine	Claudication improved, died later of cerebral hemorrhage
A G	34 M	Polycythemia vera, hypertension	Red, painful acria, increased blood volume and locally large spleen	Phenyhydrazine	Died one year later of cerebral hemorrhage
F B	63 F	Compensatory erythrocytosis, pulmonary fibrosis, asymptomatic erythromelalgia	Good pulses, burning pain relieved by cold, high blood count and hemoglobin	Deferred treatment	
J D	31 M	Acrocyanosis, primary dysfunction	Good pulses, cold, purple hands, no pain		
14734+	27 M	Acrocyanosis, crisis marasma	Cold, numbness in extremities, heart metabolism rate = 7.8 per cent		
B J	27 F	Acrocyanosis, crisis marasma, endocrine disturbance	Four weeks after childbirth numbness and swelling appeared on the lower extremities, oligospermia	Finestray extract	Still under treatment

the cauda equina and the roots in a spina bifida occulta (9) relieve vascular spasms of the extremities. Pre-operative novocain block with temporary relief from spasm in the affected parts gives the best indication for the relief to be expected.

Tabs, syringomyelia, sclerosis multiplex should be excluded from the possible causes of an angio-spasm. Spastic hemiplegia and anterior poliomyelitis show in some cases, a marked vascular spasm, relieved by peripheral nerve block. A traumatic perineuritis, following fractures or even mild contusions, produces painful circulatory disturbances. An amputation-neuroma is responsible quite often for the cold cyanotic stumps, which are so often unnecessarily reamputated. Any localized vascular disease arteritis, arterio-sclerosis, thrombosis, may produce an additional spasm of the vessel, stimulating sometimes, a purely functional disturbance. Of the endocrine disturbances, a low metabolic rate with some other evidence of hypothyroidism has been found not infrequently in women around the menopause. Possibly a parathyroid hypofunction is at play but thyroid medication is remarkably efficient in relieving these spasms and warming up cold hands and feet. The spastic anemia of stonecutters, which occurs as a result of the vibration of the air hammer (3000-5000 a minute) cramped position of fingers and, in addition, a prolonged contact with a cold tool, is not infrequently seen in the Indiana limestone district (5). We have observed one such case. Intermittent attacks of cramps in the musculature of the calf in excitable, high strung individuals may be one of the early signs of intermittent hypertension. The reaction of patients of such a temperament to adrenalin, heat or constriction of the arm is frequently inverted (20)

We have enumerated only such secondary vascular spasms as have come under observation there may be more. But an effort should be made to exclude all known etiological factors before the diagnosis of a true Raynaud's disease is made. The situation here is similar to that discussed previously in connection with Buerger's disease. With increasing knowledge of specific causative factors, the idiopathic syndromes become more and more infrequent.

2. *Isosperalysis* The same observation applies to erythromelalgia, a very rare disease (3). Our 3 cases all had a polycythemia and thus are secondary vasodilatations. Characteristic of erythromelalgia are the attacks of burning sensation in the presence of increased temperature of the acria which is relieved by elevation and cold baths, but greatly aggravated by heat. The diagnosis of acrocyanosis, a syndrome poorly understood, but supposedly due to a paralysis of small veins with intact arterial inflow was made in 3 cases.

The classification given may need revision from time to time. It serves its purpose by outlining therapy which is sometimes etiological, but more often, because of our meager knowledge of the causative factors, simply symptomatic.

#### TREATMENT OF PERIPHERAL CIRCULATORY DISTURBANCES

In the congenital type of arteriovenous fistula early radical operations, preferably done in several stages under regional anesthesia, have been successful in our experience but late cases show such irreparable damage to the tissues that a permanent edema or even gangrene cannot always be averted.

In burns, frost bite and electric injuries, unless acute spreading infection is present, the greatest

conservatism is indicated. Efforts to increase collateral circulation should be promptly instituted.

In metallic poisoning by lead or arsenic, the established methods used in freeing the body from these substances have shown remarkable improvement in the vascular changes.

In traumatic aneurisms the obliteration of the sack with temporary or permanent proximal ligation seems the safest procedure. Complete excision of the sack with end-to-end arterial suture sacrifices too many collaterals. Our experience during the World War with the latter procedure was not favorable.

Inflammatory reactions if a specific agent can be found or if autogenous vaccines are available are treated etiologically.

In Buerger's disease with its unknown etiology, non-specific foreign protein therapy is still the most efficient treatment. Whether it should produce some reaction and fever as originally suggested or whether small subreactionary doses are sufficient, is debatable. In addition, factors that aggravate vasomotor changes such as nicotine, cold, psychic insults are possibly eliminated. The disease has all the clinical and histological earmarks of a hyperergic inflammation before this subsides no surgical therapy should be instituted. Infected teeth and tonsils are removed not so much to influence the process in the vessel but to prevent further sensitization. A generous use of vasodilators, chiefly theobromine with luminal, often gives subjective relief. Physiotherapy if adequately and consistently given is valuable. Outside of contrast baths, exercises and whirlpool baths, the most helpful device is the electric cradle, which must be used continuously at night, and, in acute cases day and night. The temperature should be around 100 degrees Fahrenheit. When the inflammatory reaction subsides with resulting stenosis or obliteration of the arteries and there is a demonstrable spasm of the collateral vessels, a sympathectomy may be considered. Of 20 cases only 3 were advised to have an operation, 1 refused and in 2 the results have been indifferent.

The degenerative lesions, heavy plaques of the intima, calcified stenotic vessels, can naturally not be influenced. Much can be accomplished, however, by increasing the motor power of the heart and raising the normal but previously high blood pressure to a level which insures enough inflow against the increased peripheral resistance. That particularly in early cases the prognosis is not bad is amply demonstrated by many observations where gradual obstruction of the main arteries, in the presence of adequate cardiac func-



Fig. 2. Blood vessel visualization in a patient with normal arterial tree. Note the cubital artery with the recurrent branches around the elbow, the radial interosseous and ulnar arteries. A large phlebectasis is visible medial to the radial artery.

tion is followed by a compensation of the impaired circulation. In spite of absent peripheral pulse the foot of such patients is warm, of normal color and tolerates exercise.

Desensitization of the foot with alcohol injections into sensory nerves has been practiced by Smithwick and White. We have only 2 patients in this series in whom this method was used. The sensory nerves are exposed above the ankle below the point where they give their last motor branches and injected with alcohol. Both patients obtained complete relief at the time but both legs had to be amputated months later. The greatest objection to the method is that it destroys important collateral arteries along the

nerves and that the anæsthetic foot, which is usually gangrenous already may be exposed to a great deal of injury and spreading infection.<sup>1</sup>

Morphine should be used as sparingly as possible. Sometimes one is able to improve circulation to a great extent, but meanwhile the patient has become a drug addict and will complain of pain for which there is no objective evidence.

When an amputation becomes inevitable it should be urged with the greatest emphasis and executed under a low spinal anæsthesia at the proper level. The passive attitude of many physicians in regard to amputation, has caused a great deal of unnecessary suffering or even death

#### TREATMENT OF FUNCTIONAL VASCULAR OCCLUSIONS

When the cause of vascular spasm is found in definite irritative lesions, such as cervical rib, occult spina bifida, and amputation neuroma, the removal of these factors produces gratifying results. In patients with causalgia, following mild injuries, the decontaction of the inflamed, hyperæmic nerve was followed by amazing improvement in 2 of our own cases. Some diseases of the central nervous system, such as tabes, syringomyelia, may exhibit visceral or peripheral vascular spasms. These findings, together with attacks of crises may necessitate the advice and co-operation of the neurologic surgeon. Early cases of hypertension sometimes complain of "rheumatic" pains in the muscles, cramps in the calves, as a symptom of vessel spasm. In such patients a thorough medical examination is indicated. Young women before puberty and women near the climacteric may exhibit marked vasomotor irritability if the basal rate is low, adequate thyroid medication has been found almost specific, although the disturbance is probably pluriglandular.

Most important are local anatomical changes in the vessel wall that produce reflector spasms in the same vessels and in the collaterals. We have already touched on this problem in discussing the treatment of Buerger's disease. When we regard Buerger's disease as a sensitization of the entire vascular system to some unknown and perhaps non-specific agent, the logical treatment is to quiet down this allergic reaction, and then, in a completely quiescent stage, if there is still demonstrable vessel spasm in the new collaterals, perform a sympathectomy. These obliterated, healed arterial segments act as a nerve plexus and a continuous source of abnormal vascular reflexes.

Removal of such obliterated arterial segments has been suggested. We have had no experience with it.

The diagnosis of a true idiopathic angiospasm, Raynaud's disease can be made only when all secondary forms of spasms have been excluded. The mild cases may be treated with conservative measures of physiotherapy and vasodilators. But in the progressive forms, sympathetic gangliectomy effects a real clinical cure. In fact, we believe that when Raynaud's disease is not benefited by sympathectomy the diagnosis must be revised and a secondary type of spasm searched for. While there is a great deal of controversy as to the peripheral, local or a central cause for spasm in Raynaud's disease the clinical results with such an operation are most striking. That the results are not equally satisfactory in the hands of some surgeons may be due to (1) improper selection of cases, (2) incomplete operations.

While technical details have no place in this paper of the many approaches suggested in the literature, we prefer an extraperitoneal approach through the anterior abdominal muscles to the lumbar sympathetic chain. Following the removal of the chain the result is noted, the other limb being used as a control and only if the results are definite is the other chain removed.

For the cervicothoracic sympathectomy which requires the removal of the stellate, first and second thoracic ganglia, the posterior approach with resection of the first and second rib and transverse process is used. Here again only one side should be removed at the first operation, and careful postoperative study should determine whether the operation is worth while.

That an absence in improvement is not due to the fault of the method can be illustrated by stating that chains of lymph vessels, lymph glands, fibers of the endothoracic or prevertebral fascia have been taken for the sympathetic chain. Therefore, a histological control of the removed specimen is important.

In the vasodilator disturbances, polycythæmia must be first excluded (3). Secondary vasodilations, just as secondary vascular spasms, are much more frequent. The improvement of the blood picture in treated polycythæmia is followed by relief from the burning pain in the extremities. In the true erythromelalgia, which is very rare, radium packs seem to offer the most relief. In acrocyanosis, a paralysis of the small venules is said to exist (16). The disease is not painful or progressive, but rather disturbing to the patient. Our personal observations would suggest a pitu-

<sup>1</sup>Very promising results have been obtained with intermittent negative pressure by Reid and Bierman. (This method may revolutionize the conservative treatment of obliterative vascular diseases.)

itary disturbance but because of the impossibility to administer active preparations by mouth we have not drawn any therapeutic conclusions.

#### SUMMARY

This brief outline of peripheral vascular disturbances illustrates the large number of etiological factors that have to be considered in order to arrive at adequate therapeutic measures. These patients are not medical or surgical cases. They may require orthopedic, ophthalmological or neurologic study. Only the combined effort of group study will result in accurate diagnosis and successful treatment.

#### BIBLIOGRAPHY

1. ADSON W., and COFFEY J. R. Cervical rib. *Ann Surg.*, 1927 lxxxv, 830.
2. BARKER, N. W. Polycythemia vera and chronic pulmonary disease. *Arch. Int. Med.*, 1931, xlvii, 94.
3. BROWN G. E. Erythromelalgia and other disturbances of the extremities, accompanied by vasodilatation and burning. *Am. J. M. Sc.* 1932 cxcviii, 468.
4. BUECKLE-DE LA CAMP H. Blutgefässdarstellung bei gefässverengenden Vorgängen. *Arch. f. klin. Chir.*, 1932, cxcviii, 790.
5. Bulletin of the United States Bureau of Labor Statistics, No. 236, Washington, 1918.
6. DE TAKATS, GEZA. The cutaneous histamine reaction as a test for collateral circulation in the extremities. *Arch. Int. Med.*, 1931, xlviii, 769.
7. Idem. The differentiation of organic and spastic vascular occlusions. *Ann. Surg.* 1931 xlv, 321.
8. Idem. Vascular anomalies of the extremities. *Surg., Gynec. & Obst.* 1932 lv, 22.
9. DITTRICH, R. J. Lumbosacral spina bida occulta. *Surg., Gynec. & Obst.* 1931 lili, 18.
10. GREGG, C. B. Endarteritis obliterans and Kaeltebrand. *Beitr. z. path. Anat.* 1930 lxxvii, 195.
11. HILLMUTH MARGOT. Ueber Gefässveränderungen bei der Frostgangrän. *Arch. f. klin. Chir.* 1930, cxviii, 92.
12. JAEGER, ERNST. Zur pathologischen Anatomie der Thromboangiitis obliterans bei juveniler Extremitätengangrän. *Virchow's Arch. f. path. Anat.* 1932 cxcviii, 526.
13. JONES, C. A. Studies on peripheral vascular phenomena. *Surg. Gynec. & Obst.*, 1932 lv, 731.
14. KAVNITZ JULIUS. Chronic enderuk ergotism; its relation to thromboangiitis obliterans. *Arch. Surg.*, 1932 cxcv, 1135.
15. KUTTLER H. and BARUCH M. Traumatischer segmentararter Gefässkrampf. *Beitr. z. klin. Chir.* 1929, ccc, 1.
16. LAMONT F. Les Acrocyanoses. Paris: Masson et Cie 1929.
17. McKITTRICK, L. S., and ROOT H. I. *Diabetic Surgery*. Philadelphia: Lea and Febiger 1928.
18. SAMUELS S. S. New diagnostic sign in thromboangiitis obliterans. *J. Am. M. Ass.*, 1929, xcii, 1571.
19. SMITHWICK R. H., and WHITE, J. C. Elimination of pain in obliterative vascular disease of lower extremity: technique for alcohol injection of sensory nerves of lower leg. *Surg. Gynec. & Obst.*, 1930, li, 394.
20. V. BERGMANN G. *Funktionelle Pathologie*. Berlin: Julius Springer 1932.
21. WHITE PRISCILLA. *Diabetes in Childhood and Adolescence*. Philadelphia: Lea and Febiger 1932.

nerves and that the anesthetic foot which is usually gangrenous already may be exposed to a great deal of injury and spreading infection.<sup>1</sup>

Morphine should be used as sparingly as possible. Sometimes one is able to improve circulation to a great extent, but meanwhile the patient has become a drug addict and will complain of pain for which there is no objective evidence.

When an amputation becomes inevitable it should be urged with the greatest emphasis and executed under a low spinal anesthesia at the proper level. The passive attitude of many physicians in regard to amputation, has caused a great deal of unnecessary suffering or even death.

#### TREATMENT OF FUNCTIONAL VASCULAR OCCLUSIONS

When the cause of vascular spasm is found in definite irritative lesions, such as cervical rib occult spina bifida, and amputation neuroma, the removal of these factors produces gratifying results. In patients with causalgia, following mild injuries, the decortication of the inflamed hyperemic nerve was followed by amazing improvement in 2 of our own cases. Some diseases of the central nervous system, such as tabes, syringomyelia, may exhibit visceral or peripheral vascular spasms. These findings, together with attacks of crises may necessitate the advice and co-operation of the neurologic surgeon. Early cases of hypertension sometimes complain of rheumatic pains in the muscles, cramps in the calves, as a symptom of vessel spasm. In such patients a thorough medical examination is indicated. Young women before puberty and women near the climacteric may exhibit marked vasomotor irritability if the basal rate is low, adequate thyroid medication has been found almost specific, although the disturbance is probably pluriglandular.

Most important are local anatomical changes in the vessel wall that produce reflector spasms in the same vessels and in the collaterals. We have already touched on this problem in discussing the treatment of Buerger's disease. When we regard Buerger's disease as a sensitization of the entire vascular system to some unknown and perhaps non-specific agent, the logical treatment is to quiet down this allergic reaction and then, in a completely quiescent stage, if there is still demonstrable vessel spasm in the new collaterals, perform a sympathectomy. These obliterated, healed arterial segments act as a nerve plexus and a continuous source of abnormal vascular reflexes.

Removal of such obliterated arterial segments has been suggested. We have had no experience with it.

The diagnosis of a true, idiopathic angiospasm, Raynaud's disease can be made only when all secondary forms of spasms have been excluded. The mild cases may be treated with conservative measures of physiotherapy and vasodilators. But in the progressive forms, sympathetic gangliectomy effects a real clinical cure. In fact, we believe that when Raynaud's disease is not benefited by sympathectomy the diagnosis must be revised and a secondary type of spasm searched for. While there is a great deal of controversy as to the peripheral, local, or a central cause for spasm in Raynaud's disease the clinical results with such an operation are most striking. That the results are not equally satisfactory in the hands of some surgeons may be due to (1) improper selection of cases, (2) incomplete operations.

While technical details have no place in this paper of the many approaches suggested in the literature, we prefer an extraperitoneal approach through the anterior abdominal muscles to the lumbar sympathetic chain. Following the removal of the chain the result is noted, the other limb being used as a control, and only if the results are definite is the other chain removed.

For the cervicothoracic sympathectomy which requires the removal of the stellate, first and second thoracic ganglia, the posterior approach with resection of the first and second rib and transverse process is used. Here again only one side should be removed at the first operation, and careful postoperative study should determine whether the operation is worth while.

That an absence in improvement is not due to the fault of the method can be illustrated by stating that chains of lymph vessels, lymph glands, fibers of the endothoracic or prevertebral fascia have been taken for the sympathetic chain. Therefore, a histological control of the removed specimen is important.

In the vasodilator disturbances, polycythemia must be first excluded (2). Secondary vasodilatations, just as secondary vascular spasms, are much more frequent. The improvement of the blood picture in treated polycythemia is followed by relief from the burning pain in the extremities. In the true erythromelalgia, which is very rare, radium packs seem to offer the most relief. In acrocyanosis, a paralysis of the small venules is said to exist (16). The disease is not painful or progressive, but rather disturbing to the patient. Our personal observations would suggest a plu-

<sup>1</sup>Very pronounced results have been obtained with intermittent negative pressure by Reed and Berrington. (This method may revolutionize the conservative treatment of obliterative vascular disease.)

cessfully resected the pylorus for cancer, Wolfer had introduced gastro-enterostomy and Hahn had performed nephrectomy.

The *Annals* at its inception had the distinction of being the first journal in the English language devoted exclusively to surgery, and under the editorship of Pilcher and his English associate Keetly it attracted the principal contributions of both American and English surgeons. Among those ap-

pearing in the first volume we read the names of Fenger, Gibney, Park, Senn and Wier of the United States; Fenwick and J. Hutchinson, of England, and Shepherd of Canada. Here appear Parkes' great article upon Gunshot Wounds of the Small Intestine and Ros-



Lewis Stephen Pilcher

well Park's Fat Embolism. In the seventh volume we find Senn's monumental contribution on intestinal obstruction and resection. Crile appeared in 1891 and William Mayo in 1893. The list of its contributors during this half century is the roll call of America's greatest surgeons. To maintain a journal through fifty years upon such a plane to admit nothing cheap and tawdry, to insist upon scholarly presentation and scientific truth

in all contributions to have served so efficiently the changing science of surgery requires an editor with courage, culture, scientific attainments and ideals. To Lewis Stephen Pilcher American surgery owes a great debt.

ALLEN B. KANAVEL.

## THE ROUTINE EXAMINATION OF PERIPHERAL BLOOD VESSELS

THE tremendous amount of study which has been devoted to the question of the peripheral vascular diseases during the past few years has resulted in the accumulation of a mass of valuable data. One important result of the study is the knowledge which leads us to believe that there are thousands of people who have advanced peripheral vascular disease and never have any impairment of function which brings them to consult a doctor. The result of this is an increasingly conservative attitude in the treatment of patients who develop gangrene or symptoms from their peripheral vascular disease. For the past 15 years the treatment of the condi-

tion known in this country as thromboangitis obliterans or Buerger's disease has gradually become more conservative. Considerable impetus to the conservative treatment was given by Meleny and Miller in 1925 when they showed the great tendency for the spontaneous development of a collateral circulation in this disease. Their studies also showed that there was not the same tendency in cases of arteriosclerosis. Their work has been amply confirmed. Unfortunately and perhaps as a result of their study of the collateral arteries, there has remained a more or less hopeless attitude concerning the treatment of arteriosclerotic conditions of the extremities. Recent studies seem to indicate that this is the wrong attitude and that with proper treatment the arteriosclerotic patients



can often establish a circulatory balance which will allow them to resume useful and active occupations without the necessity of amputation. In the Vascular Disease Clinic at the Cincinnati General Hospital we are adopting just as conservative treatment for arteriosclerotic patients as for any other type of organic arterial disease.

Another important outcome of the recent intense interest in peripheral vascular diseases is the great importance of recognizing these conditions early and the institution of measures which will materially reduce the incidence of those accidents which often result in processes with which the reduced circulation cannot cope and which may require amputation of the extremity. The simple measures of warmth to the feet, avoidance of injury and infection

the care of the skin, vascular exercises, and the optimum level of the resting extremity have been repeatedly stressed. Recently there has been a revival of interest in the use of an intermittent negative and positive environmental pressure as a means of promoting the establishment of an active collateral arterial circulation.

Now it becomes an important duty to teach the medical profession to examine all of the peripheral pulses and to endeavor to estimate the vascular sufficiency particularly of the legs, in the routine examination of all patients. The preventive measures applied as a result of these studies will undoubtedly lessen materially the serious surgical conditions which are now arising from unrecognized peripheral vascular disease. MORT R. REID.





*RC Coffey*

# MEMOIRS

---

ROBERT CALVIN COFFEY

WE think of pioneers in relation to the development of the material resources of a new country subduing a wilderness of forests and plains but there have always been spiritual pioneers who despite the unaccustomed surroundings of a primitive country, through their own resources develop a genius for meeting human problems

So Dr Robert Calvin Coffey with romantic zeal organized himself, if one may so speak of it, because his campaign was individualistic, and not only in pioneer days but all his life attacked surgical problems which had tried the courage and resources of the best men in the surgical profession from the time that surgery began to do its part in alleviating the miseries of mankind Large in mind in body, he was great in courage and in desire to help those who appeared doomed to a life of misery or to untimely death

We think with admiration of the Cavaliers who came into Virginia and the Carolinas and Georgia, and who themselves or through their descendants influenced so greatly the material social, and spiritual development of America and left indelible impress on scientific progress—Ephraim McDowell J Marion Simms W E B Davis and many others

Dr Coffey was born October 20 1869 in Caldwell County North Carolina He received his education in the local schools attended the Globe Academy and later went to Kentucky where in 1892 he was graduated from the Kentucky School of Medicine at Louisville

On graduation from medical school Dr Coffey started practice in Moscow a small town in the mountainous district of northern Idaho A year later he returned east to Junction City Kansas, to marry Miss Clarissa Ellen Coffey, who recently had moved to Kansas with her parents from Lenoir North Carolina and who was of the same stock as himself, with the same basic education and the same ideals for living After they were married they traveled on together to Moscow And to this fine woman wise as few women are wise he owed much of his success

His work in Idaho was that of a country practitioner doing a moderate amount of general surgery but he was laying the foundation for the splendid work, in

that early day largely experimental which resulted so greatly for the benefit of surgery. In 1900 he moved to Oregon and settled in the beautiful city of Portland, which was to become one of the great cities of the Pacific Coast. There was at that time in Portland a hospital which had been operated by a group of citizens and which had been unsuccessful. Dr Coffey told me that the owners were so glad to get rid of the hospital that they did not inquire whether or not he had the money to pay for it, and he was so glad to get something to do that he was more than willing to accept the responsibility.

Although Dr Coffey had visited us in Rochester on several occasions I first met him, really to know him, in 1905 at the annual meeting of the American Medical Association in Portland. At that time he chartered a steamboat and took about two hundred of us on a beautiful ride on the Columbia River and one of its wide tributaries. It was a great group of men on the boat that day from Chicago, Boston, New York, Philadelphia, and all parts of the country. Too generous in his hospitality to count the cost of the boat trip, Dr Coffey on that occasion unconsciously made us aware of his capabilities and of the many ideas he had in mind for scientific progress.

Too poor in those early years to develop such a laboratory as he needed, his experimental work was carried out with small equipment and little aid. He attacked one surgical problem after another.

Dr Coffey was markedly individualistic, but as time went on he gathered around him in Portland a fine group of men who were devoted to him, developed an excellent modern hospital and consistently played a great part in the development of surgery, not only in the Northwest, but of America and the world. He was in constant attendance on medical society meetings in all parts of the country and abroad and he always contributed to the success of the meetings, presenting papers on subjects that had baffled the profession. Always welcomed by his confreres abroad, Dr Coffey on his last visit to Europe, not long before his death, was received with equal honor in recognition of his great contributions to surgery.

I shall not go into the details of Dr Coffey's contributions to surgical progress, for instance, the removal of the head of the pancreas and the joining of the pancreatic duct and the duodenum, the transplantation of the common bile duct into the duodenum, the extirpation of the urinary bladder for carcinoma, radical procedures for the removal of carcinoma of the rectum and the lower sigmoid. His work on the transplantation of the ureters into the sigmoid and rectum, which he carried out with success, was classic. This operation has been adopted by surgeons throughout the world, making it possible at last for the miserable unfortunates born with exstrophy of the bladder and those with incurable leaking fistulas of the bladder to be restored to well-being and enabled to take up their life work.

With his zest for living and accomplishing Dr Coffey was a man who might not have been able to grow old cheerfully, and time is inexorable. It perhaps would have been difficult for him to adapt himself to the limitations brought by years, to accept the demands of the new generation, seizing opportunity to develop a world of their own. When travel by airplane came into operation, he welcomed it with great enthusiasm. It fitted in with the mind and spirit of the man, it was conquering new things. And when death came to him at the age of sixty four as the result of an airplane accident, tragic end to a great life, he was after all, leading on as ever a pioneer in a new field of scientific progress.

WILLIAM J MAYO

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

**I**N his excellent book<sup>1</sup> Cockayne has compiled in one short volume practically all of the facts that are known about the inheritance of skin diseases. The purpose of the book is twofold: first, to stimulate dermatologists not only to collect and publish information about families with inherited defects but also to report isolated examples of the same defect; for one of the facts about which we are almost entirely ignorant is the ratio of the isolated cases of a defect to the family group.

The second object of the book is to enable geneticists to see by the data given what defects are suitable for further study. They can then collect more information to elucidate some special problem.

There are fifteen chapters. The introductory chapter reviews the subject of Mendelian inheritance. The other chapters are devoted to physiological abnormalities, metabolic errors, errors of development of elastic tissue, dyskeratoses, ectodermal dystrophies, abnormalities of the teeth and nails, disorders of growth, vasomotor abnormalities, and dental anomalies associated with major disorders of development.

For the average medical reader, the first chapter reviewing the subject of Mendelian inheritance is apt to be a difficult one to follow. The remaining chapters, however, make most interesting reading. There are only a few illustrations, but the pages of the book are full of interesting family diagrams.

The bibliography is very complete and is sufficient evidence of the large amount of painstaking work the author has expended on this book. It is a book that every dermatologist and every physician interested in genetics should have on his shelves. We heartily recommend it.

EDWARD A. OLIVER.

**I**T was the original purpose of Clephan and Hill to prepare an elementary handbook on radium<sup>2</sup> for the needs of the nursing and technical staff working in connection with the radium therapy. As the work progressed, it seemed advisable to expand the subject and thus make it possible for the book to serve a wider purpose. The preparation of the booklet was undertaken at the suggestion of Professor Russ who has written the introduction.

This histological aspects dealing with the dis-

covery of radio-activity and radium form the introductory chapter. The physical properties of radium are presented briefly. There follow chapters upon the principles of radium therapy, methods of applying radium and radon and the complications and contra indications of radium therapy.

The principles and results of treatment of cancer of the buccal cavity, rectum, breast, uterus, and skin as practiced in various American and European clinics are discussed. A detailed description of the construction of radium needles and tubes and a discussion of the care and precaution in handling radium are particularly useful.

This presentation is one of the best of several recent attempts to review the principles and technique of radium therapy concisely in a small volume. The subject is presented in a clear and accurate manner. To physicians who are interested in gaining a brief and accurate statement of radium therapy this little volume is highly recommended.

MAX CUTLER.

**I**N a volume of 434 pages<sup>3</sup> Foedix discusses the fluid and mineral equilibrium in the body as understood today and considers rather extensively the disorders in the body which have fluid and mineral retention as their theoretical etiological factor. Foedix believes that epilepsy, eclampsia of pregnancy and infancy, migraine, angina pectoris, asthma, allergic diseases, gout, hypertension, pernicious anemia, polycythemia, some vulgaris, nervous and psychic disturbances have water and salt retention as a common factor in the causation of symptoms. Certain constitutional changes and aging are likewise attributed in part to faulty fluid and mineral balance. The book is filled with citations to clinical observations and experimental work which support the author's views.

The production of epileptic attacks considered to be due to temporary accumulation of fluids constitutes a basis for a rational therapy, the aim of which is the prevention of retention and mobilization of water and minerals. Eclampsia is presented as essentially the same problem of storage and cortical irritation, and it is possible to regulate this state in a manner which prevents retention and the flux can be followed out over long periods of time. The author feels that the same pathogenesis and therapy is indicated in migraine. Exudative diathesis,

<sup>1</sup> INHERITED ABNORMALITIES OF THE SKIN AND ITS APPENDAGES. By E. A. Cockayne, D.M. F.R.C.P. 1st ed. London: Oxford University Press, 1911.

<sup>2</sup> AN ELEMENTARY HANDBOOK OF RADIUM AND ITS GENERAL USE. By D. F. Clephan and H. M. Hill. London: Oxford University Press, 1911.

<sup>3</sup> A NEW APPROACH TO DIETETIC THERAPY. METABOLISM OF WATER AND MINERALS AND ITS DISTURBANCES. By Eugene Foedix, M.D. Boston: Richard C. Badger, 1911.

ickets, and eclampsia of infancy seem to be different manifestations of similar water and mineral retention in the infant. The author discusses fluid retention which is noted after meals in low temperatures on exercise and on lying flat all of which bring on attacks of angina pectoris. Allergic diseases are attributed to a basis of general predisposition and retention of fluids. A vicious cycle consisting of retention of fluids with contraction of small arteries explains hypertension. The pathogenesis of primary anemia is presented as achlorhydria and retention of fluids and swelling resulting in increased hemolysis.

The author discusses constitutional types which are underlying factors in the production of these disorders the aqueous type being one which has a tendency to store water and salts the salinus constitution is the second type and it is characterized by retention of salts but not with great amounts of water and it is commonly met in people with decreased elimination of hydrochloric acid by the stomach. The hirsute constitution is distinguished by an instability of the water and mineral content of the organism while the euhydric type is considered the optimal balance.

All of these conditions are treated by an antiretentional diet which has no specific qualities but generally consists of a liberal amount of proteins and nucleoproteids a moderate restriction of carbohydrates a severe restriction of fats a restriction of liquids, and a free utilization of the natural sources of all vitamins. Mineral intake is not emphasized.

ML. HENRY BAUER.

THE purpose of this volume is not to present a treatise on any part of the broad field of urography but rather to emphasize the need for close correlation between the urologist and the roentgenologist and to show by the actual reproductions of many films what the roentgenologist may expect to find in the presence of various lesions and to indicate the proper interpretation of the shadows which are present.

Despite the wealth of urographic material which is to be found in recent texts on urology and radiology the work of Lower and Nichols<sup>1</sup> offers additional valuable information on all the roentgenographic problems of urinary tract diagnosis. A brief but sufficiently comprehensive, history of the development of various phases of urography is given. The important points in the roentgenographic examination of the urinary tract are stressed. Examination of the male urethra bladder ureter and kidneys is discussed in a clear concise manner and valuable points in technique and mode of interpretation are properly emphasized. A most instructive chapter deals with the indications for a roentgenographic examination of the upper right abdominal quadrant. The following 371 pages comprise an atlas of excel-

lent roentgenograms with accompanying case history summaries of a most instructive nature. Special attention is given to urethrography a rather neglected field, and cystography. Intravenous and retrograde pyelography is discussed in detail and many illustrations serve to depict the outline found in every type of urinary pathology. This volume deserves the attention of urologists in general both for thorough academic instruction and as a text for continued reference.

VINCENT J. O'CONNOR

THE fourth volume of *The Practitioner's Library of Medicine and Surgery*<sup>2</sup> is a consideration of non-traumatic surgical conditions. The book is a compilation of material written by twenty authors and covers discussions on local infections neoplasms in general, regional surgery and surgery of the various glands of the body. The book is arranged systematically is concisely written although some of the chapters appear sketchy. The volume is profusely illustrated, which is a great boon to the average practitioner for whom this volume is intended. All in all a wealth of material is covered and should be a valuable addition to a surgical library.

The chapter on surgery of the pericardium heart, and the great blood vessels by Beck is worthy of especial commendation. It brings forth in a comparatively few pages, our present knowledge of this important and most interesting surgical specialty. Another interesting chapter worthy of consideration is that by Wangenstein on diseases of the peritoneum mesentery and omentum. His post-operative treatment of peritonitis is especially interesting in which he recommends the introduction of a Levin tube passed through the nose with the employment of suction as obtained by water aspiration whereby distention is eliminated and vomiting disappears. Koontz's chapter on hernia offers more perhaps than most textbooks or systems covering this very important branch of surgery. Koontz's discussion on sliding hernia is a welcome addition as this very interesting type of hernia is generally given little prominence in most textbooks. The chapters covering the surgery of the gastrointestinal tract are rather brief. It must be said however that only the meat has been preserved, all superfluous material having been eliminated.

On surgery of the prostate gland although this volume is published in 1933 one sentence makes mention of the burning of a tunnel through the obstructing adenoma with specially designed instruments in certain selected cases. The chapter on surgery of the pancreas is not extensive giving rather a sketchy bird's eye view of diseases of this organ.

This book represents a tremendous amount of work and effort and is a welcome addition to one seeking worth while information in the tremendous field of non-traumatic surgery. CARLE I. GREENE

<sup>1</sup> ROENTGENOGRAPHIC STUDIES OF THE URINARY SYSTEM. By William E. Lower, M.D., F.A.C.S., and Bernard H. Nichols, M.D., F.A.C.R. St. Louis: The C. V. Mosby Company 1933.

<sup>2</sup> THE PRACTITIONER'S LIBRARY OF MEDICINE AND SURGERY VOL. IV—NON-TRAUMATIC SURGERY. New York and London: D. Appleton and Company 1933.



THE third edition of Boyd's *Surgical Pathology*<sup>1</sup> presents a number of additions and revisions. The additions include brief sections on the metabolism of tumors, chronic follicular gastritis, high temperature deaths following cholecystectomy, non-obstructive hydronephrosis and autolytic peritonitis. Among the sections which have been altered or entirely rewritten are those on the action of radium on tumors, secondary jejunal ulcer, acute intestinal obstruction, cholesterolosis of the gall bladder, varicose veins, and osteitis fibrosa. The general form and character of previous editions has been preserved. Thus the choice of material is confined to "those aspects of pathology which will prove useful to the surgeon." There is a constant effort to correlate anatomical changes with alterations in function and the resultant clinical manifestations. The method of presentation is uniformly direct and compact. Consequently the book yields much information of genuine interest to the practicing physician and is easily read. In the handling of controversial subjects opposing views are briefly presented and the author is neither dogmatic nor evasive in his conclusions. Thus in the section on the thyroid gland Rienhoff's view of the origin of nodules is accepted on its merits and the author states with refreshing directness that "the more one studies the problem of goiter the more one is convinced of the mistake of separating toxic adenoma from exophthalmic goiter." The difficult controversy on the significance of chronic mastitis as a precancerous lesion is succinctly but adequately handled. On this question the author is inclined to accept the views of Bloodgood as opposed to those of Ewing and Cheate. With few exceptions the literature has been brought well up to date. One might perhaps regret that in the discussion of the theories of shock no mention is made of some of the more recent work on the subject, particularly that of Blalock and his associates.

In general the book should serve a very useful purpose to students, internists, and surgeons. With relatively little overlapping it fills in the gap between works on the purely anatomical and the purely clinical aspects of disease. LAWRENCE JACQUES.

THE book on blood transfusion by Dr. Wildegans<sup>2</sup> gives a concise general review of the subject of transfusing blood. The entire subject is treated very well under six chapters which are adequately illustrated.

After a brief historical account, the problem of blood grouping is considered. The various classifications of blood groups are given and the classification recommended by v. Dungern and Hirschfeld is considered in detail. The chief discussion pertains to the hereditability of the blood characteristics and contends that the structures of A and B corpuscles never appear in the offspring unless they are present

in one or both parents. The remainder of the chapter deals with the agglutination and hemolysis of red blood corpuscles, and various recommendations are given for differentiating between true and pseudo-agglutinations.

In the selection of donors the importance and necessity of preliminary cross-agglutinations is emphasized. The indirect methods (employing known test sera) and direct methods (employing cell suspensions and sera of recipient and prospective donor) are given in detail. Emphasis is attached to the importance of carrying out these tests before each transfusion of blood.

The effect and fate of the transfused blood are also dealt with in a special chapter. Attention is called to the fact that the medium by which a transfusion of blood exerts its favorable influence is still a moot question. It is suggested that the beneficence of a blood transfusion may be attributed to the preservation of the transfused red blood cells, to recuperation, or to a rapid new formation of blood corpuscles in consequence of the stimulus exerted on the hematopoietic organs.

Under technique the direct and indirect methods of transferring blood are discussed in detail. In addition acceptable methods are given for transfusing infants and small children.

As indications, the various medical and surgical conditions entailing a loss or impoverishment of one or more blood elements are enumerated. The contra-indications are given as absolute and relative. Organic heart disease with decompensation and acute cardiac dilatation are given as absolute contra-indications. The relative contra-indications, where caution is to be exercised in transfusing blood, are pregnancy, pneumonia, and severe bronchitis, diseases of the kidneys with oliguria, thrombosis, and thrombophlebitis, and a state of marked cachexia.

Finally the cases in which severe and fatal reactions occur are considered. The author repeatedly emphasizes that fatalities can almost without exception be avoided by carefully and accurately carrying out the necessary preliminary blood typing and cross-agglutination tests. E. E. BLANCK.

THE first edition of Holt's *Diseases of Infancy and Childhood*<sup>3</sup> was published in 1897, when pediatric knowledge was in a nebulous stage. Throughout the succeeding years as greater and greater advances have been made in every branch of medicine this standard textbook has been revised to keep abreast of the "rushing stream of medical progress." Throughout this period this textbook has been accepted as a standard by a generation of teachers and students. It has probably taken no small amount of courage on the part of the present revision authors to make as complete a revision of this text as they have undertaken. Eight sections have been rewritten and

<sup>1</sup> *SURGICAL PATHOLOGY*, By William Boyd, M.D., M.R.C.P. (Ed.), F.R.C.P. (Lond.), (Dipl. Path.), F.R.S.C. 3d ed. Philadelphia and London: W. B. Saunders Company 1933.  
<sup>2</sup> *DER BLUTTRANSFUSION UND TROPHEN VON FRÄHLE*. By Dr. Med. Hans Wildegans. Berlin: Julius Springer 1932.

<sup>3</sup> *HOLT'S DISEASES OF INFANCY AND CHILDHOOD: TEXTBOOK FOR THE USE OF STUDENTS AND PRACTITIONERS*. By the late L. Emmet Holt, M.D., and John Howard, M.D., Revised by L. Emmet Holt, Jr., M.D., and Rustin McLanahan, M.D. 4th ed. New York: D. Appleton and Company 1933.

new articles added. No radical departures have been made in the general plan and structure of the text. The book still gives one the impression of the old text but with a difference. There is a greater simplicity of description noticeable throughout but nowhere better illustrated than in the chapter on artificial feeding. A simple isocaloric formula isocaloric with breast milk is the basis upon which feeding formulas are built. There are just enough reservations and explanations made to this method of feeding for the student reader to know that not all babies will thrive on such a formula and yet not leave him confused by a multiplicity of formulas.

In line with most recent textbooks, a bibliography has been added at the end of each chapter. This of course makes it possible for those interested to read the original articles on the subject described.

There is little doubt that even the critically minded reader will find this book has maintained the high standard set by the deceased senior authors. In all probability it still will be the recommended textbook by the majority of teachers of pediatrics.

GERARD N. KROST

THE book on *Internal Derangements of the Knee Joint* by Timbrell Fisher<sup>1</sup> is a most excellent monograph. It shows a vast amount of careful study of clinical pathological, and experimental material. The anatomy is brief and clear and the illustrations excellent. The physiology of the semilunar cartilages is carefully treated and the possibility of regeneration from an experimental and clinical standpoint is considered. The symptomatology of the various divisions of the subject is systematically

handled. The classification of loose bodies in the joint and the illustrations of the various forms are clear and understandable. The origin of these bodies is discussed from a clinical and pathologic standpoint, as well as from an experimental standpoint.

In conclusion I would state that this book merits very thorough study and should be in the library of every general surgeon.

WILLIAM R. GURRINE.

THE book entitled *Massage and Remedial Exercises*<sup>2</sup> was written as a textbook on massage and remedial exercises. The use of massage and exercises in the treatment of injuries is well described. The chapter on the use of exercises in the treatment of stiff joints is worthy of the attention of everyone treating these difficult conditions.

The author in advising passive movements makes it clear whether relaxed or forced movements are to be used. The term "passive movement" has been a source of misunderstanding in the past, as the term passive movement has been used for both relaxed and forced movements. The only true passive movement is a relaxed one.

In order to consider all the subjects for which massage and exercises have been recommended many conditions are included in which massage and remedial exercises have few indications for example, hemorrhoids, chronic tonsillitis, enteritis, and cirrhosis of the liver. These might profitably be omitted, and more illustrations added.

As a whole the work is a valuable textbook for those interested in massage and exercise, and could well be used by physicians as a reference book in prescribing exercises.

GERTRUDE BEARD

<sup>1</sup>INTERNAL DERANGEMENTS OF THE KNEE JOINT; THEIR PATHOLOGY AND TREATMENT BY ALGOREN METHODS. By A. O. Timbrell Fisher M.C. M.B., Ch.B. F.R.C.S.(Eng.) 2d ed. New York. The Macmillan Company 1935.

<sup>2</sup>MASSAGE AND REMEDIAL EXERCISES; IN MEDICAL AND SURGICAL CONDITIONS. By Nod M. Tidy Baltimore: Williams Wood and Company 1934.

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

TRANSACTIONS OF THE AMERICAN SURGICAL ASSOCIATION Vol. II Edited by Walter Estell Lee, M.D. Philadelphia J. B. Lippincott Company 1933.

MENTAL HYGIENE IN THE COMMUNITY By Clara Bassett New York The Macmillan Company 1934.

THE PRACTICE OF SURGERY By Russell Howard, C.B.E., M.S. (Lond.) F.R.C.S. (Eng.), and Alan Perry M.S. (Lond.) F.R.C.S. (Eng.) 4th ed. Baltimore William Wood & Company 1933.

NEUROLOGY By Roy K. Grinker, M.D. Springfield, Illinois, and Baltimore, Maryland Charles C. Thomas, 1934.

OPERATING ROOM PROCEDURE FOR NURSES AND INTERNS By Henry C. Falk, M.D., F.A.C.S. With a Foreword by Eugene H. Pool, M.D. New York and London G. P. Putnam & Sons, 1934.

NATURE, M.D. HEALING FORCES OF HEAT WATER LIGHT ELECTRICITY AND EXERCISE By Richard Kovacs, M.D. New York and London D. Appleton-Century Co. 1934.

DIE GEBURTSVERLETZUNGEN DES KINDES. By Prof. Dr. Hans Naujoks. Stuttgart. Ferdinand Enke 1934.

VERSÜCHE EINER DEUTUNG DER PATHOGENESE DER SKELETTVERÄNDERUNGEN BEI CHONDRODYSPLASIA FOCALIS (Kaufmann) By Aks Wilton Copenhagen Levin & Munksgaard, 1933.

GELLENKSTIFTEN UND GELLENKPLASTIK. By Prof. Dr. Erwin Frey Vol. I—Pathologische Biologie der gelenk Pathogenese und pathologische Anatomie der Ankylosen Klinik diagnostik und Anzeigestellung. Berlin Julius Springer 1934.

NEUROANATOMY; A GUIDE FOR THE STUDY OF THE FORM AND INTERNAL STRUCTURE OF THE BRAIN AND SPINAL CORD. By J. H. Globus, B.S. M.D. 6th ed. rev. ed. Baltimore William Wood & Company 1934.

LABORATORY MEDICINE A GUIDE FOR STUDENTS AND PRACTITIONERS. By Daniel Nicholson, M.D. 2d rev. ed. Philadelphia Lea & Febiger 1934.

PATOLOGIE UND KLINIK DER GRANULOMATÖSEN BY Dr. Walter Schiller Vienna Wilhelm Mauk, 1934.

THE PRACTITIONERS LIBRARY OF MEDICINE AND SURGERY Vol. v—Thoracic Surgery Vol. vi—Obstetrics and Gynecology New York and London D. Appleton-Century Company 1934.

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVIII

APRIL, 1934

NUMBER 4

## FRACTURES OF THE NECK OF THE FEMUR<sup>1</sup>

W. RUSSELL MACAUSLAND M.D. ANDREW R. MACAUSLAND M.D., AND HAROLD G. LEE M.D. BOSTON  
From the MacAusland Orthopedic Clinic

THE efficacy of the Whitman abduction method in treating fractures of the neck of the femur has been recognized by surgeons throughout the world and the procedure for the most part generally accepted as the standardized form of treatment. When operators hesitate to adopt this method the explanation lies either in their desire to substitute a method that will eliminate the long tedious convalescence necessitated by the Whitman treatment, or in the fact that they are perplexed as to the actual effectiveness of the treatment in large series of cases. On the whole few reliable statistics have been published on the results of this method. There is not only a lack of uniformity in the tabulation of outcomes, but also a great deal of inaccuracy. As a result the percentages of satisfactory and unsatisfactory outcomes vary considerably and the lack of accurate data reflects unfavorably upon the method of treatment. As yet the methods devised with a view to shortening the convalescent period have been used in too few cases to permit us to draw conclusions as to their value. In the light of our present experience the limited application of these newer forms of treatment and particularly of operative methods should be appreciated.

It is with the twofold intention of reporting an accurately detailed account of our experience with the Whitman method, and of defining the proper place of operative inter-

ference in treatment at the present time that this article is presented. We consider that our results from the use of the Whitman method have been favorable and we shall continue to carry out the established principles of treatment that have thus far proved of value to us.

### DESCRIPTION OF CASE SERIES

Two hundred and fifty cases of fractures of the femoral neck were treated at our clinic within a period of 23 years that is from 1908 to December, 1931. The latter is the final date used for the basis of an end result. All cases in our report are listed consecutively as they came to our clinic for treatment. Of this number 159 cases were fresh fractures of the medial and upper neck, 56 were fresh fractures of the trochanteric region in which were included fractures of the base of the neck and 35 were ununited fractures. The Whitman method of reduction was used in practically all the fresh fractures and operative measures were reserved for cases of non union.

### FRESH FRACTURES OF THE MEDIAL AND UPPER NECK

*Etiology.* The usual history of a fall often due to tripping over a rug was reported by the great majority of our patients. There was only one case of a pathological fracture in our series the origin of which was traced to carcinoma of the breast.

<sup>1</sup> We desire to express our sincere appreciation to the many physicians who have helped us in compiling the case data and the roentgenographic material for this paper.

*Diagnosis* In the average case the diagnosis presents no difficulty the syndrome being well known but in the exceptional case in which the patient is not extremely incapacitated and may even walk without assistance the fracture may be overlooked. Six of our patients walked for periods varying from 2 weeks to 3 months following the fracture. In 2 of these cases an incorrect diagnosis had been made with the result that the advantage of early treatment was lost. Attention is called to these cases in which the power of locomotion persists in order to emphasize the importance of noting carefully all symptoms and signs following a fall in the case of an elderly individual and to stress the importance of taking roentgenographic views from several angles. Recently Leonard and George made a valuable contribution to the roentgenographic study of these fractures when they discovered that it is possible to obtain vertical views of the femoral neck with a curved film holder (Fig. 1).

*Pathology* An understanding of the pathology of this fracture especially in its relation to treatment, is essential to satisfactory handling of the lesion.

Certain bone changes take place that must be taken into consideration in treating these fractures. The first of these is a generalized atrophy a variation that is observed in any fracture. It is a well known fact that a normal bone that has been put at rest for a week undergoes a loss of lime salts sufficient to show in a roentgenogram. In a fracture of the hip therefore, it is expected that atrophy will be observed. Whether the atrophy in the proximal fragment may be explained by disuse alone is a subject of discussion, but it is our opinion that this factor in itself may be responsible. The head of the femur immediately following the fracture is placed practically out of compression muscle pull and slight motion do not produce even a small proportion of the strain to which it has been accustomed. The atrophy therefore, may become extremely severe and surgeons who have intervened in old cases of non union have observed that the structure of the head is practically lost.

In addition to the generalized atrophy a certain amount of absorption of bone takes

place at the site of the fracture. Thus absorption is not peculiar to fractures of the neck of the femur for in fractures of any long bone there is a definite tendency toward absorption of both bone-ends during the first stage of healing. In an ordinary transverse fracture of the femoral shaft, which heals normally this absorption of bone may amount to a quarter of an inch. It is not surprising then to find absorption amounting to one half or three-quarters of an inch in fractures of the neck, even when healing takes place and if union is considerably delayed or non-union persists the femoral neck may entirely disappear. The causes of absorption may be normal incidental to the re-adjustment of circulation and the beginning of bone repair or abnormal due to excessive use or strain at the site of non union, where the bone-ends are markedly atrophied and unable to stand such strain.

*The impacted fracture* For many years there has existed a common misconception of the pathology of certain fractures of the femoral neck. A particular type of fracture has been considered to be "impacted," the term connoting a certain stability and voluntary control of the limb as the result of the penetration of one fragment into another. The development of this theory of impaction is explained to some extent by inaccurate interpretation of the roentgenogram which always shows a foreshortening of the femoral neck due to overlapping of the fragments. As a matter of fact, true impaction of the fragments in these fractures does not occur. The fracture designated as impacted is either one of the incomplete variety or a complete fracture in which, because of the good preservation of the capsule and periosteum, only slight deformity is present and some power of movement is retained. It is possible too, that in some cases a slight interjunctional splintering is present which, by causing the motion to be more limited when the muscles tighten to protect the affected area during examination prevents the determination of a complete fracture line. The fallacy of this idea of impaction is apparent when we consider that in these fractures the posterior or the weaker part of the neck is crumpled, while the

front and stronger part being only cracked merely buckles but is not displaced. The fallacy seems all the more definite when, with the lapse of 2 or 3 weeks during the period of observation, the fracture line is seen to become complete and the fragments loosen.

The early teaching was to leave these fractures alone, or to use protection only for fear that disturbing the fragments would promote non union. As a rule these fractures when treated by rest alone do not heal, and in the course of a few weeks when body weight is borne, a slight twist or turn results in the breaking up of the temporary stability. At this stage however the advantage afforded by early manipulation has been lost. In the infrequent case in which union takes place, deformity in the form of shortening, adduction, and outward rotation of the leg develops. Of particular significance is the disturbed relation between the femoral neck and shaft, producing a coxa vara. In time, the interference with the function of the joint leads to the development of arthritic changes with their accompanying pain and limitation of motion.

The so called impacted fractures practically always call for the same treatment as other fractures of the neck of the femur. Under proper care any displacement of the fragments is prevented. It is only when there is no displacement, or in the rare case of coxa valga, or when the patient is extremely elderly, that disturbance of such a fracture is unwarranted.

**Union.** Bone repair in the intracapsular type of fracture takes place almost entirely by internal callus formation. Contrary to the view held by many observers, it is our opinion that wherever union occurs there is some external callus formation, although it may be difficult to demonstrate it in the roentgen film. This is so because its area is not represented vividly or because the callus is too slight in amount to be demonstrated. Some indication of this external callus is seen when cases are treated operatively.

The formation of bone in these fractures is slow, due undoubtedly to the fact that nourishment and protection of new bone come chiefly from the distal fragment in which the circulation remains undisturbed. Just what

TABLE I—GENERAL FEATURES—159 CASES

	Cases	Per cent
Males	34	21
Females	125	79
Age		
20-29		1
30-39		4
40-49		9
50-59		20
60-69		43
70-79		35
80-89		23
90+		3
Unrecorded		12
		159
Hip Involved		
Left		78
Right		68
Unrecorded		13
		159

part the proximal fragment plays in osteogenesis is much disputed. There are surgeons who believe that the head is not viable from the moment a fracture occurs while others believe that the fragment is nourished through the teres ligamentum. In this connection it is interesting to study the findings in anatomical dissections of ununited fractures of the femoral neck. The proximal fragment, as stated, shows marked atrophy of the cancellous structure, cortex, and cartilage covering the capitulum. Over the end of the fragment is a heavy fibrous covering or pannus which must be removed in order to observe the interior structure. To the outer rim of this pannus are usually attached the remains of the capsule, as well as a new fibrous tissue formation that runs out and extends to the rim of the acetabulum. This tissue is a new formation and is not found in the normal hip. We believe that it is through this tissue that the blood supply comes to the head. Just when and how long it takes this fibrous sheath to form we have not been able to determine. In view of these findings, it is our opinion that the femoral head is always living.

Due to the slowness of repair, at least 6 months is required to obtain union in the typical case. Roentgenograms should be taken at regular intervals, and we desire to stress particularly the importance of interpreting them correctly. It is possible to note the progress of union about the second month,

the shorter fragment shows considerable absorption and the edge of the bone shows a penciling from atrophy. Definite sharpening of the corners will be noted causing the fractured site to have the same appearance that a sequestrum does in an osteomyelitis. The texture of this fragment contrasts with that of the shaft fragment in which there is considerable atrophy, but in which the edge of the bone shows only lightly without any heavy penciling. By the third or fourth month new circulation has developed a pons has grown across from the edge of the acetabulum and new bone cells are present throughout the capital fragment.

A great deal of care must be taken not to misinterpret the radiograms at the end of the second or third month. The marked absorption that is usually seen with a thickening of bone on either side of a lozenge shaped area may be incorrectly interpreted as an ununited fracture. At this stage of healing such an appearance is of no importance provided the fragments are still in good position. In fact it is a stage of union and if one persists in immobilization the thickening begins to be absorbed and as the shell on either side absorbs the center begins to fill in. This process is seen as a rule only in fractures that are practically intrajoint fractures although occasionally a somewhat similar picture is seen in injuries to the joint itself or in an improperly treated fracture of a long bone.

#### TREATMENT

The many difficulties—mechanical nutritive and physical—that the surgeon encounters in treating these fractures are well known. In only a comparatively few cases are these obstacles so great that treatment is to be regarded as futile and the majority of these fractures when treated on the same principles as other fractures, are amenable to proper care.

In general the fundamental principles governing the treatment of these fractures are as follows:

1. Early care, including the treatment of shock and the prevention of the development of pneumonia and cardiac disturbance.
2. Accurate reduction of the fragments

3. Maintenance of the fragments in good position for a sufficient period to ensure union.
4. Careful after-care.

5. The institution of function to prevent excessive atrophy of the proximal fragment.

6. Careful observation of the process of healing.

*Reduction* when possible should be made immediately after the injury. After the lapse of more than a week a time reposition of the fragments by a conservative form of treatment is more difficult, and may even be impossible because of the presence of blood clots and fibrous tissue.

There are in use at the present time three methods of reduction: the Whitman abduction method, various forms of traction and operative methods. The selection of the method depends upon the age of the patient, the presence of complications, the type of fracture and the experience of the surgeon in a particular line of treatment.

*The Whitman method.* Of these methods the Whitman (14) procedure has been the most widely used, and surgeons who have had the most experience in this field are of the opinion that it is still the method of choice for the majority of cases. The technique of the procedure is well known. The manipulation is carried out with the patient narcotized. As the anæsthetic, ether may be used with safety provided the patient is cared for properly. In our entire series of 250 cases there were only 11 cases of pneumonia during the first 3 weeks of treatment, and in only 5 of them is there a possibility that ether was the direct cause of the complication. In a number of elderly patients we have successfully used large doses of morphine for a narcotic. It is administered as follows: Two hours before reduction the patient is given 3 grains of luminal and 1 hour later  $\frac{1}{8}$  grain of morphine sulphate and  $\frac{1}{200}$  grain of hyoscine hydrobromide are injected subcutaneously. The patients have no recollection of the manipulation and remain narcotized for about 10 hours after the reduction.

The care of the patient immediately following the application of the plaster spica is of prime importance, as hypostatic congestion develops easily in these cases. A firm mattress

with a fracture board beneath it should be used. When the patient is elderly, it is well to elevate the head, sides, and foot of the bed alternately for 2 hour periods. At least twice a day the patient should be turned in bed, so that he lies for 20 minutes at a time first on his face and then on his side. This turning of the patient and elevating of the bed should be continued until the patient is able to sit in a wheel-chair once a day.

Of vital importance too, is the after-care instituted to stimulate the circulation in order to promote early union and keep the musculature in tone. By various arrangements of bars and pulleys the patient can move himself about in bed. Twenty four hours after reduction he should sit on the edge of the bed and by the third day he should be out of bed sitting in a wheel-chair, and if possible, walking with crutches. Early weight bearing not only stimulates the circulation, but also keeps up the patient's sense of equilibrium and helps to make him confident that he will be able to walk again. While the limb is in the spica muscle contractions should be carried out at varying intervals throughout the day 100 times at each session.

At the expiration of 4 or 5 months it is often advisable, and particularly so in elderly patients, to insert a joint in the plaster spica at the knee. This arrangement allows a little motion at the knee joint and the patient is encouraged to use his limb. In some cases it is possible to remove the portion of the spica from the midcalf to the toes at the end of the fourth month but care must then be taken to control the consequent swelling of the foot by applying a firm flannel bandage. After 5 months the anterior half of the spica may be removed temporarily to allow baking and massage. At this time a moderate amount of motion may be allowed the hip joint, and mild weight bearing on the toes is of advantage.

The limb should be kept immobilized for at least 6 months. The modern trend to cut short the period of immobilization in treating fractures near joints, and to institute early active motion to incite bony growth, is to be questioned. In our clinic we have tried both weight bearing and non weight bearing methods and from our experience we conclude that

the indiscriminate use of early motion of joints proximate to fractures is to be avoided. The rational view is to wait for healing and to put no strain on the site of fracture, until the surfaces have united sufficiently to bear that strain.

Upon the final removal of the plaster spica, baking, deep massage, and gentle passive exercises are carried out. Considerable muscle re-education is necessary to effect a complete return of strength. When the roentgenogram shows evidence of increased union and the patient appears to be sufficiently active and suffering no pain, full weight bearing may be allowed. If necessary a caliper may be worn to minimize the amount of weight bearing for a time.

*Traction methods.* Traction methods, until recently have been used only when the patient could not tolerate the plaster spica or was suffering from shock or complications. The limited use of these methods in the past has been due to the difficulties presented in their application and the maintenance of the position of the fragments. With the introduction of newer forms of skeletal traction such as the Jones traction splint and the skeletal traction splint devised by Anderson which are more available and simple and accurate in application these methods are being used more widely, and we shall without doubt see further development of this form of treatment. Within the past year we have used these newer traction methods in a large number of cases and a report of the end results is published when sufficient time has elapsed to permit judging the outcomes.

At the time of this paper we are able to report the end results in only 4 cases where traction was used. The Boehler method was used in all 4 cases. One patient, 63 years of age, at the time of the fracture, is now (9 months after reduction) walking without a limp and has a firm bony union. The second patient, 63 years of age, who was an emphysematic with an old pulmonary embolism, without a limp (Fig. 2) 7 months after fracture. The third patient, 85 years of age, had had an embolism at the time of the fracture and is now walking without a limp. The fourth patient, 69 years of age, 9 months after the fracture, is walking without a limp.



*Operative treatment of fresh fractures* It is our opinion that at the present time operative measures should be reserved for a selected group of cases. Whether this group should include a larger number of cases than are now recognized as operable that is whether our treatment tends to be too conservative yet remains to be determined. We do not agree however with the group of operators who stressing in particular the desirability of shortening the long convalescent period believe that every fracture of the femoral neck is operable from the moment that it takes place. To be sure it is difficult to combat such a view for we are all anxious to restore function within as short a period as possible. Experience, on the other hand teaches us to doubt the reasonableness of such an opinion and further statistics are needed to substantiate it.

Provided no contra indications as to age and physical condition are present, operation is justified in the following instances when alignment of the fractured surfaces cannot be obtained by the Whitman method when the apposition of the fragments is considered unsatisfactory and when the patient cannot tolerate the Whitman method.

Only four operative methods have been recommended for the treatment of fresh fractures the Hey Groves proximal pegging operation the Albee graft method, the Jones (8) graft method and the Smith Petersen fixation. At the present time we are considering whether operative reduction of the fracture may not have a place in the treatment of selected cases under 60 years of age. Certainly in many fractures at other sites in which conservative manipulation fails to result in accurate reduction, simple exploration with anatomical reposition gives perfect results.

Of the four methods in use, the most satisfactory in our opinion is the bone-graft method for such an operative procedure not only provides for fixation of the fragments, but it also introduces a callus-forming substance into the fractured area. The Jones method, which was introduced only within the past year seems to have several advantages over the Albee procedure. Dr

Jones (9) has not yet published statistics of his end results as he is waiting for a period of at least 18 months to elapse from the time of operation before issuing a report (Fig. 3).

The Smith Petersen method has been used more extensively than any other operative procedure in the treatment of fresh fractures. This method has not been accepted favorably by a number of surgeons because it involves the use of a foreign substance. We are among those operators who are opposed to the use of any foreign body in the treatment of a fracture since it has been our experience that when metal is in contact with bone, liquefaction or even necrosis and infection develops, with its customary inhibitory effect upon the formation of callus. Such a liquefactive process develops in the presence of any metal substance regardless of its shape or size.

Our experience with operative measures in fresh fractures has been limited to 2 cases. In 1 in which the fracture was not recognized for 6 weeks, the tibial graft method of Albee was used with success. In the other case a Whitman reconstruction operation was performed 2 weeks after the fracture, owing to the necessity of a shorter convalescent period, and the need for absolute assurance that the hip would be stable.

*Prognosis* In general, it may be estimated that under efficient care, instituted promptly a stable joint with sufficient motion for the routine functions of life may be obtained in approximately 80 per cent of the fractures occurring at this site. In 60 per cent of these cases, practically normal motion may be expected which will allow the patient to be more or less vigorously active. In the 20 per cent remaining some support may or may not be necessary in walking and the patient may have a slight limp and experience pain and fatigue, but the hip will be stable, and the motion will be sufficient to allow the patient to perform the ordinary tasks of life.

The failure to obtain union does not necessarily preclude the recovery of a useful limb and with proper ambulatory apparatus a patient may sometimes be made very comfortable. There were 3 patients in our series who had fair function in spite of the non union.

TABLE II.—END-RESULTS—AVERAGE TIME OF POSTOPERATIVE INTERVAL—4 YEARS

Ages	Cases	Method of treatment	End-results			Roentgenographic study of 60 Cases			
			Good	Fair	Poor	Bony	Fibrous	Non-union	Not obtained
30-39	3	Whitman	2			2			2
40-49	3	4 Whitman 1 tibial graft	2 1			1			2
50-59	2	Whitman	1	1	1	0			2
60-69	33	51 Whitman 1 Boehler 1 reconstruction operation	17 2 1	3	11	7 1	4	9	1
70-79	18	16 Whitman 1 Boehler 1 general traction	10 1	4	3 1	6 1	2	4	4
80-89	8	6 Whitman 1 Boehler 1 support	4 1	1	1 1	2 1		1	4
Ages recorded		Whitman	1		1	1			
Summary	91	84 Whitman 1 Boehler 1 traction 1 support 1 tibial graft 1 reconstruction operation	54	17	18	23	8	17	31
Percentages			61.5	18.7	19.8	28.5	13.8	18.4	

**Complications** Among the later complications that are seen when union has occurred is atrophy, and it is seen especially in cases that have not been reduced early and held properly in fixation. Some shortening always occurs, its degree varying with the amount of bone absorption and depending to a great extent upon treatment. Not infrequently, even with good union, a hip that has been severely damaged will continue to give trouble on account of the arthritic changes that take place in the joints of older individuals.

**Limitation of motion of the knee joint** is a fairly frequent complication owing to the arthritic changes often present in these senile cases, and to the prolonged immobilization necessitated by treatment in a plaster spica. The firm advocates of open intervention claim that when the limb is treated conservatively in a plaster spica, the patient is left with an other disability in the form of a stiff knee. In our experience we have not found that this sequela is so serious. Surprisingly few of our patients had an arthritic process at the knee joint and in reviewing our end results only a small number complained of any limitation of motion. It is of course, possible to avoid this complication by using a traction method whenever there is a question as to the outcome.

#### ANALYSIS OF SERIES OF CASES

Our series of subcapital and transcervical fractures is comprised of 159 cases. (It is unfortunate that our classification of fractures according to their site has not been sufficiently explicit to allow determining the exact number of fractures situated close to the head.) One hundred and forty three of these fractures were treated by the Whitman method, 6 were treated by the Boehler traction, 1 was treated by general traction, 1 by the Bradford splint, and 1, by support only. Two patients were treated by operation. No treatment was attempted in 5 cases, 4 being elderly patients in poor general condition and 1 was denied treatment by her family. Approximately 80 per cent of these fractures were treated within a few hours or a few days of the injury. Six patients were treated from 2 to 3 weeks after the fracture, and 9 were treated after an interval of 1 to 2½ months. The delay in treatment was due either to the condition of the patient or to the failure of the attending physician to recognize the fracture.

**End results** A request was sent to each patient asking him to report for examination either to our clinic, or to the physician in his community who had referred him to us for treatment. In case the patient was unable to

report he was requested to outline in detail his present condition. The difficulty of acquiring data on these cases, the majority of which are elderly at the time of injury is apparent. We were particularly handicapped by the fact that our series extended over a period of 23 years. Many of the patients had died, many had moved from their former residences and a few refused examination. Information was secured on 140 cases, and of this number we consider that 91 are suitable for study. We arrive at this conclusion in the following manner:

Total cases	59
Cases not treated	5
Results unknown	19
Results unclassified (see explanation below)	13
Deaths during treatment	31
Series used for study	91

As is shown in the accompanying chart 84 of the 91 cases were treated by the Whitman method, 3 were treated by the Boehler method, 2 by operation, 1 was treated by general traction and 1 by support only.

In classifying these cases as to the recovery of function we used the following standard:

<i>Good.</i> Practically normal motion in the hip joint. Walking well without support. No pain. More or less vigorous activity as walking several miles a day.	
<i>Fair.</i> Walking with or without a cane. Good stability. Some limp. Some pain or fatigue. Motion sufficient for ordinary tasks of life.	
<i>Poor.</i> Walking with crutches. Pain. Instability. Non-union.	

Our estimation of the functional results as based upon this classification showed that 61.5 per cent of the patients secured good functional hips, 18.7 per cent had fair motion and 19.8 per cent were poor outcomes. In Table II showing the end-results in relation to the ages of the patients, it will be noted that all of the patients under 60 years of age with the exception of 1 secured satisfactory results and that 43 or 73 per cent of the patients over 60 years of age had satisfactory function following treatment.

The percentage of poor results should not be accepted without some explanation. In 4 cases, non-union was the result anticipated from the beginning of treatment, 2 of the patients were over 80 years of age and in poor

condition, one refused to co-operate and the fourth patient had considerable bony atrophy of the upper end of the femur at the time of the injury. If we eliminate these 4 cases in which the presence of associated factors precluded a satisfactory result, the number of poor outcomes averages 15 per cent, a figure that is more encouraging than most of the statistics in literature.

In the so called unclassified group are those cases in which, for some reason, the functional end result could not be judged accurately. In a few cases the presence of a complicating disease or lesion prevented us from determining the functional outcome. In 4 cases death from an intercurrent disease occurred from 6 to 9 months after reduction, and 1 patient left our care before the after treatment had been completely carried out.

*Roentgenographic study.* The acquisition of X-ray material presented even more difficulty than securing the clinical data. Many patients had died, others were too elderly to report for examination and still others refused to co-operate. Roentgenograms were finally obtained in 60 cases.

Number of cases on which clinical reports obtained	91
Cases in which patients died, but on which friends, relatives, or the family physician sent us clinical reports	16
Patients refusing to have X-ray	7
Patients living too far from hospital or office to report	8
Number of roentgenograms obtained	60

Thirty-five or 58.3 per cent, of the 60 roentgenograms showed good bony union, 8 or 13.3 per cent showed fibrous union and 17 or 28.4 per cent, showed non-union. These figures should not be accepted as presenting a true roentgenographic study of our series of 91 cases. The discrepancy in 28.4 per cent ununited fractures as estimated from the radiograms, and the 19.8 per cent poor functional outcomes is at once apparent. Had we been able to secure a complete set of roentgenograms, our report on the presence of union would have varied considerably. Figures 4 and 5 show the union in a series of fractures several years after reduction had been obtained following treatment by the Whitman method.



Fig 1 Vertical views of the femoral neck obtainable with a curved cassette. A After reduction, with fragments in good apposition. B fracture with anterior rotary displacement.

**Details on deaths** During the course of treatment, that is within the period of 6 months following reduction death occurred in 31 cases, making a fatality rate of 20 per cent. This total includes all deaths that occurred within this period regardless of the cause of the fatal outcome. In order to find out what is the *actual death rate* it is necessary to separate those deaths that are directly traceable to the effect of injury and treatment, from those due to an intercurrent disease or to the presence of concomitant factors, such as senility. Of the 31 deaths, only 11 may be traced directly to the effect of the injury and treatment. Eight of these patients died of pneumonia within the first 3 weeks of treatment, 2 patients, both over 80 years of age, died within a few days of the injury, and 1 patient died of an embolus on the fifth day following the reduction. Of significance were the advanced ages of the 8 patients who died of pneumonia the youngest being 72 years and the oldest 90 years.

Death in all the other cases with the exception of one on which details are lacking occurred within 1 to 5 months after reduction. In 7 of these cases senility and the poor general condition of the patients precluded recovery as 2 of the patients were in the late seventies and the other 5 were over 80 years of age. Three patients of this group developed pneumonia. Intercurrent lesions were responsible for the fatal outcome in the 12 other cases. If in our estimation of the mortality rate we eliminate these 19 deaths that are not directly attributable to the fracture the fatality rate is reduced to 7 per cent a remarkably low figure (see Tables II and III).

#### FRACTURES OF THE TROCHANTERIC REGION

The fractures that occur in the trochanteric region may be conveniently classified according to their site as follows

1 The *intertrochanteric fracture* in which the line of breakage follows the intertro-

TABLE III—DEATHS OCCURRING DURING TREATMENT

Total deaths	31
Causes	
Pneumonia	11
Died within first three weeks of treatment	8
Ages between 72 and 90 years	
Died late in treatment	3
Ages, 74, 87, 88	
Intercurrent lesions	19
Died within first week of treatment	3
Senility, 2	
Embolus, 1	
Died late in treatment	
Senility	4
Embolus	1
Uremia	2
Cardiac disturbance	6
High blood pressure	1
Cerebral hemorrhage	2
Unknown	1
	31
Ages	
50-59	1
60-69	2
70-79	12
80-89	11
90	1
Unknown	4
	31
Method of treatment	
Whitman	30
Boehler	1
	31
Where treated	
Home	7
Hospital	24
	31

Note—89 per cent over 70 years of age.



Fig. 3. M.C. Fracture of the neck of the femur in emaciated woman 63 years of age with pulmonary tuberculosis of long standing. End-result 3 years after reduction by the Boehler traction method, showing solid bony union, with shortening of the neck. Perfect function.

chanteric line and may or may not extend into the trochanters or shaft. In this group are included fractures of the base of the neck.

2. The *transtrochanteric fracture* in which the fracture line passes across the upper femoral shaft and through one or both trochanters.

### 3. *Isolated fractures of the trochanters*

In our experience the most common site of fracture has been the intertrochanteric area and 32 of our 56 cases were of this variety. How many of the 32 fractures occurred at the actual base of the neck, we are unable to determine, as it has been our custom to classify such fractures under the intertrochanteric group. Thirteen fractures in our series were situated in the transtrochanteric region and 5 were isolated fractures of the greater trochanter. No pathological notes are available on the 6 remaining cases.

These fractures, like those of the medial and upper femoral neck, occur most frequently in patients over 60 years of age and likewise

women are affected more often than men. The injury is usually traced to a fall. In isolated fractures of the greater trochanter the fracturing force is usually direct and violent in nature while in the etiology of fractures of the lesser trochanter muscle pull plays an important rôle. Displacement is usually slight in these fractures, except when the line of breakage passes directly through the femoral neck, when there is a consequent displacement upward of the trochanter and external rotation of the limb as in fractures of the medial and upper neck. Occasionally in intertrochanteric and transtrochanteric fractures a *coxa vara* is seen.

Fractures of the trochanteric region are admittedly easier to treat than fractures of the upper neck, since the fracture line passes through bone that has an ample blood supply. A plaster spica or some form of traction is used to hold the fragments in position. Recently we have used the Jones traction splint successfully in treating several of these cases. Union is solid in  $2\frac{3}{4}$  to 3 months following the use of this method.

In spite of the ease of treating these fractures and in spite of the fact that the prognosis is excellent, it is amazing to note the number of cases that are allowed to heal with a lessening of the angle of the neck and shaft. Figure 6 shows a case in which the normal angle was not restored. In the presence of such imperfect mechanical conditions, an arthritic process rapidly develops and gives rise to further disability.

*Analysis of 56 cases.* Fifty five cases were treated by a plaster spica, and the Jones traction splint was used in the odd case. Practically all patients had been treated within a few hours or a few days of the time the injury was sustained.

*End-results.* In the compilation of these end results we encountered the same difficulties as in accumulating data on the fractures of the upper neck. As the accompanying chart shows, the majority of patients were over 70 years of age at the time of the fracture and undoubtedly many of the inquiries that were returned unclaimed had been sent to patients who had died. Of the 56 cases, 30 are suitable for study.

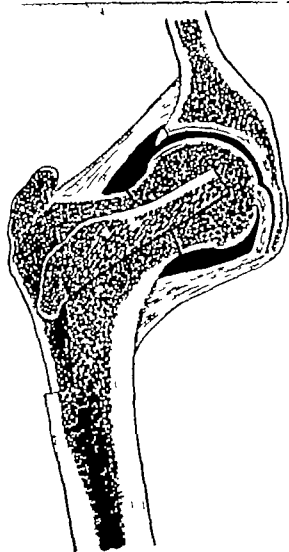


Fig 3. Bone-graft method of Jones. "Diagrammatic section showing the structure of the bone-graft." (Courtesy of Dr Jones.)

Total series of cases	56
Results unknown	13
Results unclassified	4
Deaths during treatment	9
	26
Series used for study	30

In the unclassified group there were 2 bedridden patients, there was 1 patient who had had tuberculosis at the time of the fracture and died within 6 months, and the fourth patient tore off the spica on the day following its application and refused further treatment.

In estimating the functional recovery we used the same standard as in judging the outcome in fractures above the base of the neck.



Fig 4. R.M. Transcervical fracture in woman 77 years old. End result 3 years after Whitman reduction. Bony union. Excellent function with slight limitation of abduction.

The end results as based on this classification showed that 26, or 87 per cent, obtained good functional joints, 1, or 3 per cent, obtained fair functional motion and 3 or 10 per cent, were poor outcomes. In one intertrochanteric fracture in which good motion was obtained there remained a slight coxa vara, and another good result was complicated by slight displacement of the greater trochanter. A few cases in which the lesser trochanter was involved showed slight absorption of this process. Four patients complained of arthritis of the knee.

An analysis of the poor results revealed that one patient aged 79 years and in poor general health at the time of the injury, had been unable to tolerate a regular spica. Another patient aged 78 years was feeble and in poor health. In the third case which was a badly comminuted intertrochanteric fracture the shoulder of the distal fragment had been absorbed by the end of the sixth week following reduction. The patient was only 35 years of age.



Fig. 5. Roentgenograms of a series of trans cervical fractures, taken several years after reduction by the Whitman method. All show bony union and have excellent functional results.

In the acquisition of the roentgenographic material on the trochanteric fractures, we were more fortunate than in compiling data on fractures of the upper neck, and 23 roentgenograms were obtained on the series of 30 cases. Of these 87 per cent showed bony union and 13 per cent, non union.

*Analysis of deaths.* Nine deaths occurred during treatment that is, within the 6 months period following the application of a plaster spica. In 6 of these cases the effect of the injury or of treatment was responsible for death, although the ages of 68, 88 and 98 in 3 cases precluded a satisfactory outcome. Three of these patients died of pneumonia within the first 3 weeks of treatment, 2 died of pulmonary embolus, 1 during the manipu-

lative reduction and the other on the third day after reduction and 1 patient died of myocarditis on the second day. One patient died of diabetes within the first week of treatment. While the causes of death in the 3 remaining cases of the series were unavailable, we do know that 1 patient died within the second week of treatment and the other at the end of the third month. If we eliminate these two cases in which we do not know the cause of death, and the case in which death was due to diabetes the fatality rate is 11 per cent. It will be noted that this death rate is higher than the fatality rate of 7 per cent that we estimated in our series of fractures of the upper neck. Other writers have also called attention to the higher death rate in fractures



Fig. 6. F.S. Roentgenogram of comminuted intertrochanteric fracture. At left, before reduction at right, end result 4 years after reduction showing good bony union but slight coxa vara.

of the trochanteric region (see Tables IV and V)

#### UNUNITED FRACTURES

The determination that a fracture of the femoral neck remains ununited can usually be made with accuracy when, after a sufficient time has been allowed for healing free motion is demonstrable between the bone-ends and the roentgenogram shows a line of non union with absorption of the fractured surfaces. Limited abduction pain instability a spring to the hip and shortening are other signs indicative of a non union. The surgeon, in diagnosing these ununited fractures, must ever bear in mind that osteogenesis in this area is slow and that at least 6 months is required for complete healing in the average case and from 8 months to a year if complications are present. Unless the slowness of repair is appreciated it is not unlikely that a delayed healing process or even a stage of union will be mistaken for a permanent non

union (See section on Pathology Fractures of the Upper and Medial Neck)

*Types of non union* The non union may be one of two types. In cases in which the fractured surfaces are kept properly immobilized, the head and shaft may retain their relation to each other during the process of absorption, as a result when the limb is brought down into normal position, the head is found to sit well upon the projecting portion of the neck. Such a hip is fairly stable and except for the shortening and the lump may cause little trouble. The second type of non union in which the fragments are no longer in good position is far more common. The neck has been absorbed the trochanter is displaced upward with consequent shortening and the shaft of the femur is adducted and everted. This type of non union gives rise to an unstable limb and the patient suffers pain. As a rule painful spurs and irritative processes develop although some hips may resist their formation for years. Such a condition is dis-





Fig. 7. H.D. At left, ununited fracture in woman 60 years of age. At right, end-result 3 years after Brackett operation. Note. The result would have been better had the trochanter been attached lower down on the femoral shaft. Late absorption of the distal shaft was also a complicating factor.

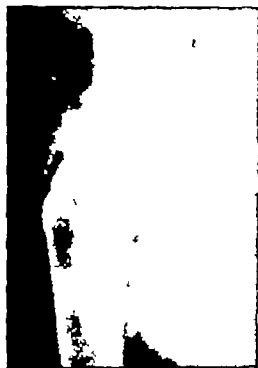


Fig. 8. N.C. End-result 8 years after Brackett operation. Patient was a woman 53 years of age.

abling and the patient is extremely limited in activity. Crutches are usually necessary and in time even support may have to be discarded and the patient becomes a chronic invalid.

*Pathology.* Upon anatomical dissection the ununited fracture shows many interesting details. The cancellous structure, the cortex and the cartilage of the capital fragment are markedly atrophied. The end of the fragment is covered with a pannus, on the outer rim of which is attached the new fibrous formation to which we have referred previously. Over the end of the base of the neck is a fibrous covering which is usually somewhat heavier than the covering of the head. When this covering is removed the bone is found to be in good condition; the atrophy is only moderate, and usually the remains of the old strengthened band in the anterior portion of the cortex are found. Between the fragments can be demonstrated new joint formation that is, one or more cavities lined with epithelium and containing viscous joint fluid. Under pressure, sliding of the opposed joint surfaces upward can be demonstrated the amount varying

TABLE IV—END-RESULTS OF FRACTURES OF THE TROCHANTERIC REGION

Age	Cases	Method of treatment	Type of fracture	Functional end-results			Roentgenographic results		
				Good	Fair	Poor	Boony	Non union	Not obtained
30-50	3	Plaster spica	1 Intertrochanteric 1 transstrochanteric			1	1	1	
50-60	1	Plaster spica	Unknown						
50-59	3	Plaster spica	1 Intertrochanteric with detached lesser trochanters 1 Intertrochanteric with detachment of both trochanters	2					1
60-69	6	5 Plaster Jones splint	1 Intertrochanteric 1 Intertrochanteric with detached lesser trochanters 1 fracture of greater trochanter 1 Impacted Intertrochanteric	2					
70-79	13	Plaster spica	7 Intertrochanteric 1 Intertrochanteric with detached greater trochanter 1 Intertrochanteric with detachment of both trochanters 1 transstrochanteric 1 Unknown	4	1	2	4		1
80-89	4	Plaster spica	Intertrochanteric 1 Intertrochanteric with detached lesser trochanters 1 transstrochanteric	2			1	1	
Unknown		Plaster spica	1 Intertrochanteric with detached lesser trochanter 1 Intertrochanteric with detached greater trochanter				1		1
Summary	30			26	1	1	20	3	2
Per cent				87	3		67	10	

Average time of postoperative interval 4½ years.

from a quarter of an inch to a full inch. When the sliding is minimum in degree the hip is fairly stable, while the reverse is true of a hip that allows motion of an inch. In our observance of cases of non union, we have noted that the weight bearing strain is shunned by the capitulum and is borne entirely by the heavy fibrous ligaments and scar tissue attached to the base of the neck.

**Causes of non union.** This is a subject that has been so thoroughly discussed in medical literature that further elaboration is unnecessary. The question of the etiology is still not completely solved and we cannot yet explain why a case that has been properly treated shows rapid absorption of the neck.

A study of the possible causes of non union in 27 fractures which were ununited when we saw them for the first time showed that the following factors played a part

Failure to recognize fracture  
No particular treatment instituted  
Traction for a few weeks

Cases  
4  
3  
5

Plaster applied with limb in improper position, or removed early  
Questionable treatment, such as fracture set, or operation performed  
Absorption of neck following proper treatment  
Early history unavailable

8  
4  
1  
2

It will be noted that lack of treatment, or faulty treatment, was the primary cause of non union in practically all these cases and in only one case had the hip been accurately reduced by the Whitman method, and a plaster spica worn for 6 months. A distressing feature of the 3 cases in which the fracture was recognized but the patients were allowed to lie in bed with the limb merely protected by sandbags was that their ages ranged from 29 to 50 years.

A careful study was made to determine the causes of non union in the 17 poor outcomes in our series of 91 cases. As we explained under the discussion of the results in these cases non union was the outcome anticipated from the beginning of treatment in 4 of the 17 cases. In the 13 remaining cases we were unable to account for the development of non



Fig. 9. M. C. At left, ununited fracture in a woman 53 years old; at right, end-result 3 years after Whitman reconstruction operation.

union the fractures had been reduced by the Whitman method within a few hours or a few days of the injury and a plaster spica worn for a period of 2 to 5 months, when the roentgenogram showed definite extensive absorption of the femoral neck. In 6 of these ununited fractures reconstruction operations were performed.

**Treatment.** Surgical intervention is the only means of treating non union and many operations have been advanced for the relief of ununited fractures. The choice of method depends upon the local pathology in the head and neck and upon the age and condition of the patient. The selection will vary too with the operative experience of the surgeon. No arbitrary limits should be set as to the period of non union when different procedures are applicable, as some cases will be suitable for a bone-graft at the end of several months, while in other cases the hip may be well preserved after more than a year's time.

We shall discuss the various methods of treatment under two groups.

A. Methods applicable when both fragments are well preserved or when the capital fragment is preserved but the neck more or less absorbed.

B. Methods applicable to cases in which the femoral head is destroyed and the neck atrophied.

A. When the head and neck are fairly well preserved and when it is possible to pull the trochanter down into position the autogenous bone-graft method of either Albee or Jones is the operative procedure of choice.

In ununited fractures in which the head is preserved but the neck more or less absorbed, thus making the use of a bone-graft impractical the method described by Brackett or a method that has been mentioned by several writers and more recently has been described by Magnuson is to be recommended. The Brackett procedure consists of

placing the freshly exposed surface of the trochanter in contact with the hollowed out head, and lowering the attachments of the trochanter on the femoral shaft. It aims thereby to provide a source of viability for the capital fragment. Brackett first described this operation in 1917. On reviewing our cases we find that Dr. Andrew MacAusland carried out practically the same technique in a case in November, 1916. The patient a woman aged 52 years, had had an ununited fracture of  $3\frac{1}{2}$  years duration. When the joint was exposed at operation, the neck was found to have disappeared except for its lower anterior fragment. This fragment and a section of the trochanter with its muscle attachments were removed. The head was hollowed out and the remodeled shaft and trochanter were placed in apposition with it. The section of the trochanter with its attachments was replaced against the side of the femoral shaft as low down as possible.

It will be noted that this technique differs from that described by Brackett, in that the section of the trochanter is removed with the muscle attachments and fixed lower down on the shaft. Brackett on the other hand removes simply a small layer of bone with the attachments for reattachment later, and then removes and discards a section of the trochanter to create a fresh surface for contact with the femoral head.

Since 1916 we have used this technique, modified only as to the operative approach, in 8 other cases. Better exposure of the joint is obtained by a regular U shaped incision. Our results may be seen in Table VI. The preoperative and postoperative radiographic findings in one of these cases are seen in Figure 7. The patient at this time (11 years after the operation) has good function in her hip. Another result in a hip that was treated 8 years ago is seen in Figure 8. The patient now walks with a cane and is able to do light housework.

The method described by Magnuson which is often confused with the Brackett operation involves cupping out the head inserting the freshened neck fragment and reattaching the trochanter with its attached muscles at a lower level on the femoral shaft. It is apparent that

TABLE V—DEATHS OCCURRING DURING TREATMENT

Total deaths	9
Died of pneumonia	
Within first 3 weeks	3
Died of intercurrent lesions	
Within first week	
Pulmonary embolus	2
Myocarditis	1
Diabetes	1
Died of unknown cause	2
	9
Ages	
40-49	1
50-59	1
60-69	3
70-89	2
90	1
Unknown	1
	9
Method of treatment	
Plaster spica	9
Where treated	
Home	0
Hospital	9
	9

this procedure more than any other aims to re-establish normal anatomical relations. Provided the pathology allows its application and provided a good articular surface remains to assure a joint with free motion, it is a method to be recommended. Our experience with the method has been limited to 4 cases (see Table VI).

B In ununited fractures in which because of the extensive pathology it is impractical to attempt restoration of even approximately normal relations, some type of reconstruction operation becomes necessary. The great majority of ununited fractures are of this class. The head is absorbed the neck atrophied, and the trochanter is displaced upward to a marked degree. By means of a reconstruction operation, a hip joint may be created that is sufficiently stable for weight bearing and allows a fair amount of function.

There are three well known methods of reconstruction the Whitman (15) method, the Albee (2) method and the Lorenz (11) method. Of these the Whitman method has been used most extensively. The function following its use is not of course so satisfactory as that following the Brackett or the bone graft operation and some pain may be experienced in view of the fact that the remodeled trochanter does not fit the acetabulum accu-

TABLE VI.—RESULTS OF OPERATIVE TREATMENT OF UNUNITED FRACTURES

Method of treatment	Cases	Age	Functional results				Roentgenographic results			Died during treatment
			Good	Fair	Poor	Unknown	Good union and good position	Displacement	Unknown	
Whitman method	16	33-68					8		7	1—survival short
Brackett method	9	49-66	3				3	Non-union	3	1—survival 1—paralysis
Method described by Magnuson	4	49-60							4	
Albee method		63								
Freshening of bone-ends	3	59-67	Non-union					Non-union		
Fixation by nail		38						Non-union		
Construction of shell in acetabulum		41								

rately but it is the best means of providing a secure skeletal support. We have used this method in 16 cases and obtained excellent results. Figure 9 shows the pre-operative and postoperative radiographic findings in one of this group of cases. The patient has a remarkable range of motion; she limps only slightly; is able to go up and down stairs and does all her own housework.

The Albee method of forming a bone lever is more complicated in design and for this reason has not been more generally used.

The Lorenz method differs from the other two procedures in that it does not aim to restore the original mechanics of the hip joint but rather to construct a neoarthrosis of sufficient strength to support the body. The method has been little used in this country and the number of cases in which it has been carried out is still too small to allow drawing conclusions as to its value.

Table VI outlines our operative treatment of ununited fractures. The ages of the patients ranged from 29 to 68 years. The lack of treatment or improper treatment was the primary cause of non-union. The classification that we used in judging the functional end results is as follows:

*Good* Excellent stability; a good range of motion; no support necessary in walking; practically no pain or fatigue, and ability to pursue ordinary activities. Always slight limp.

*Fair* Good stability. Ability to get about fairly well and do light work. May or may not use a cane. Some pain and fatigue.

*Poor* Unable to walk without crutches. Pain and fatigue. Marked shortening.

It will be noted that 12 or 86 per cent of the cases in which we used the Whitman method obtained good results. It is unfortunate that we are unable to obtain the roentgenographic reports on all cases.

Our experience with the Brackett and the Magnuson methods has been limited, and on the whole the results have not been satisfactory. We believe, however, that the methods are to be recommended. Freshening of the bone-ends, as carried out in 3 of our early cases has, of course, been discarded as a method of treatment. The case in which the fixation by nailing was done was also one of our early cases, as was the case in which the acetabulum was deepened and the femoral shaft placed in apposition with it.

#### SUMMARY AND CONCLUSIONS

This study of fractures of the femoral neck is based on a series of 250 cases that were treated throughout a period of 23 years. One hundred and fifty nine cases were fresh fractures situated in the medial and upper femoral neck; 56 were of the trochanteric region and 35 were ununited fractures. Sixty-six per cent of the patients were 60 years of age or older at the time of the injury.

Of the 159 fractures of the medial and upper neck the results in 91 cases were considered suitable for study. All but 7 cases had been treated by the Whitman method of reduction and in 80 per cent the treatment had been

carried out within a few hours or a few days of the injury. The functional results as judged after an average time interval of 4 years were as follows: good, 61.5 per cent, fair, 18.7 per cent, and poor, 19.8 per cent. The roentgenographic study, which was based on the 60 roentgenograms available, showed 58.3 per cent bony union, 13.3 per cent fibrous union, and 28.4 per cent non union. (The discrepancy in the percentages of ununited fractures as based on the functional results and on the roentgenographic study is apparent, and is due to our inability to obtain roentgenograms of all cases.) The total number of deaths occurring within the 6 months period following reduction was 31 or 20 per cent. Of this number, only 11 or 7 per cent could be traced directly to the effect of the injury and treatment.

The Whitman method of reduction has, therefore, proved to be effective in establishing joints that are stable and that allow sufficient motion for the routine functions of life in 80 per cent of our cases. We aim, of course, to increase the number of satisfactory results in these fractures, but in view of the many factors that are unfavorable to union, in particular the absolute lack of capacity for repair that may exist, the question arises as to how much we may expect to better the work in this field. Undoubtedly, the early recognition of cases in which treatment by traction methods or by operative intervention is indicated will help to improve our results. The newer traction methods which tend to eliminate the difficulties of the older forms hold much promise. Surgical intervention, in our opinion, is applicable to only a small group of cases selected carefully as to age and general physique in which it is evident that the Whitman method would not be efficient. Of the operative methods in use, we prefer the bone graft method. We are opposed to methods that incorporate the use of a foreign body. The applicability of both traction and operative methods is still limited to a relatively small number of cases, and the Whitman method is the treatment of choice in the majority of cases. Until this method is superseded by one as practical and by one so simple of execution that it can be carried out by all

operators, the Whitman method will continue to be the established treatment used for this type of fracture.

Of the 56 fractures of the trochanteric region, 30 were considered suitable for study. Eighty-seven per cent resulted in good function, 3 per cent in fair function, and 10 per cent in non union. The death rate was 11 per cent. All cases with the exception of one in which a Jones splint was used had been treated by a plaster spica.

In our group of 35 ununited fractures, there were 17 in which non union was the result of our treatment. In 13 of these cases we were unable to account for the outcome; the fractures had been reduced within a few hours or a few days of the injury, and the plaster spica worn for 2 months or longer, when the roentgenogram showed extensive absorption of the neck. In the 4 other cases, the non union was the anticipated result, owing to the presence of complicating factors. The most common causes of non union in the group of 27 cases that were ununited when they first came to us for treatment were lack of early treatment and faulty treatment.

Our treatment of ununited fractures has been limited chiefly to the Whitman reconstruction operation. In the 16 cases in which this method was carried out, 86 per cent good results were obtained. When the pathology permits, we would recommend the bone graft operation of Albee or Jones, the Brackett operation, or the method recently described by Magnuson.

#### BIBLIOGRAPHY

1. ALBEE, F. H. Late end-results in ununited fracture of the neck of the femur treated by the bone peg or the reconstruction operation. *J. Bone & Joint Surg.* 1928, 1, 124.
2. Idem. Treatment of ununited fracture of the neck of the femur. *Surg., Gynec. & Obst.*, 1920, xlix, 810.
3. Idem. Treatment of fractures of the neck of the femur. *J. Florida M. Ass.*, 1931, xviii, 11.
4. ANDERSSON, R. New method for treating fractures, utilizing the web lig. for countertraction. *Surg., Gynec. & Obst.*, 1931, liv, 507.
5. BOZZICCI, L. The Treatment of Fractures. P. 104. Vienna: Maundrich, 1920. Translated by M. D. Steinberg.
6. BRACKETT, E. G., and NEW, MAY S. Treatment of old ununited fracture of the neck of the femur by transplantation of the head of the femur to the trochanter. *Boston M. & S. J.*, 1917, clxxv, 351.

7. HRY-GROVES, E. W. Treatment of fractured neck of the femur with especial regard to the results. *J Bone & Joint Surg.* 1930, xii, 1.
8. JONES, E. Trochanteric transplantation in the treatment of fractures of the neck of the femur. *J Bone & Joint Surg.* 1923 xiv 259.
9. Idem. Personal communication October 1932.
10. LARSEN, R. D. and GROVES, A. W. A cassette with convex curve. *Am J Roentgenol.* 1932 xiviii, 261.
11. LÖNNERZ, A. Ueber die Behandlung der irreponiblen angeborenen Hüftluxationen und der Schenkelhals-pseudarthrosen mittels Gabelung. *Wien. klin. Wchnschr.* 1919, xxxiii, 907.
12. MACGILLIVRAY, P. B. The repair of ununited fracture of the neck of the femur. *J Am. M. Ass.* 1932, xciviii, 1792.
13. SMITH-PETERSON, M. N. CAYE, E. F., and VAN GOMPER, G. W. Intracapsular fractures of the neck of the femur. *Arch. Surg.* 1931 xxviii, 715.
14. WHITMAN, R. A. *Treatise on Orthopaedic Surgery* P. 937 Philadelphia Lea & Febiger 1927.
15. *Ibid.* P. 964.

## THE EFFECTS OF INCREASED INTRAGASTRIC PRESSURE UPON THORACIC AND ABDOMINAL ARTERIAL AND VENOUS PRESSURES

CHARLES W. McLAUGHLIN JR., M.D. AND J. WALTER LEVERING M.D. PHILADELPHIA

From the Laboratory of Research Surgery and the Department of Surgery, Surgical Division C, University of Pennsylvania, School of Medicine

THE term acute gastric dilatation is usually associated with the late stages of increased intragastric tension. That the condition exists frequently in varying degrees is not so generally recognized. Careful study of patients after operation has convinced us that the lesion is often a progressive one. In its earliest phases the patient may complain of no symptoms although the lesion can be demonstrated by percussion, by roentgen ray examination or by the use of any tube which can be used for gastric syphonage. In its later stages the distended abdomen, the voluminous vomiting, and the increasing illness of the patient make the diagnosis a simple matter.

Much has been written on the supposed mechanisms which produce gastric dilatation. The effect of fluid loss on the volume of the circulating blood has also been discussed and the effect of salt loss on the blood reaction has received considerable attention. That changes in the gastric tension may have profound primary effects on the cardiovascular system is not so well recognized.

Plumier, Thornton and Schmidt, Frey, Dmitrenko, McIver and Runge have studied the effect of increasing the abdominal pressure on the arterial or venous pressures or both. We have not been able to find any similar studies where these pressures were measured when the stomach was subjected to acute changes in the intragastric tension except the short report of Dmitrenko. While these studies were being made, Brams, Katz and Kohn reported the effect of abdominal distention and release on the blood pressure in the carotid artery and the veins above and below the diaphragm. In the experiments reported in this paper we have not only reproduced the picture of acute gastric distention as observed in clinical cases but we have utilized pressures which we are sure exceed any commonly observed. However, since the

progressive increases in pressure in the animal were induced over a relatively short period there was not the profound loss of blood volume which may occur when the condition is more prolonged in its onset. The terminal effects on the cardiovascular system in acute gastric dilatation in the human are, therefore, probably even greater than our experiments disclose from mere acute increases in the gastric pressure.

### METHOD

Dogs anesthetized with sodium amytal, 50 milligrams per kilogram of body weight, were used as the experimental animals. A tube was introduced into the stomach through the esophagus. A midline abdominal incision was then made, the tube was tied in place at the cardia and the pylorus firmly closed by stout ligatures. The abdomen was then closed by tier suture. Cannulas were introduced into the carotid and femoral arteries, the inferior vena cava through the femoral vein and into the thoracic veins through the external jugular vein. Pressure changes in the veins were determined by means of a 1 millimeter bore straight manometer filled with 6 per cent sodium citrate. The stomach of the animal was then distended with air, the degree of distention being measured by a mercury manometer which was connected with the gastric tube through a side arm. Fluctuations in the arterial and venous pressures and the pulse rate with variations in the intragastric tension were then recorded on a kymograph. All animals were kept in the supine position during the experiment. All the experiments were of the acute type, the animal being sacrificed at the completion of the experiment. The arterial and venous pressures given in the succeeding data are the means obtained at the particular moment.

*Results.* **Venous pressure.** Whenever the intragastric tension was increased the pressure



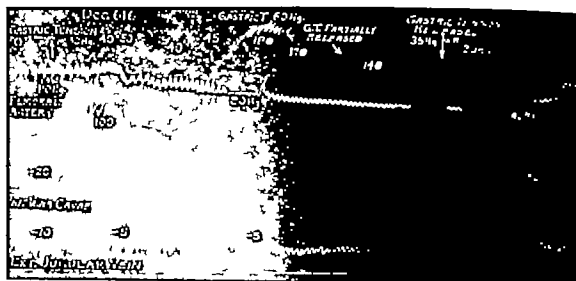


Fig 1 The effect of intragastric tension upon the femoral and superior and inferior caval pressures.

in the inferior vena cava rose promptly. With increasing gastric pressures there was an increase in the inferior caval pressure. The initial mean pressure in the inferior vena cava was approximately 10 millimeters of the citrate solution. When the pressure in the stomach was increased to 30 millimeters of mercury the mean inferior caval pressure rose to approximately 60 millimeters of the citrate solution. When the intragastric tension was gradually increased to 150 millimeters of mercury the mean inferior caval pressure rose to approximately 300 millimeters of the citrate (Fig 1). Release of the intragastric tension resulted in a prompt fall in the inferior caval pressure to approximately its initial level.

The initial mean pressure in the superior vena cava was approximately 10 millimeters of the citrate solution. Slight increases in the intragastric tension caused no change in the superior caval pressure. When however this pressure reached 30 millimeters of mercury there was in nearly every experiment a slight rise in the mean superior caval pressure. A gastric pressure of 50 millimeters of mercury caused a rise of approximately 15 millimeters of citrate and an intragastric pressure of 100 to 150 millimeters of mercury resulted in a rise of 20 to 30 millimeters of citrate (Fig 2). This was the maximum superior caval pressure which we observed. Release of the in-

creased intragastric pressure resulted in a prompt fall of the superior caval pressure to approximately its initial mean value.

**Arterial pressure** As the intragastric pressure was increased there was usually observed a fall in the femoral pressure which, when the intragastric pressure reached 30 to 50 millimeters of mercury averaged 15 millimeters of mercury (Fig 3). At times the reduction in the femoral pressure was rapid while at others it was slow. The femoral pressure usually continued to fall until the intragastric pressure reached 50 millimeters of mercury when it as a rule began to rise. In some experiments the fall continued (Fig 1) while in still others (Fig 4) no initial fall was observed, but on the contrary a rise in the femoral pressure was observed until the intragastric pressure reached 70 to 80 millimeters of mercury when a fall occurred. When the femoral pressure rose the pulse pressure decreased and when the gastric pressure was increased above 60 millimeters of mercury the mean femoral pressure frequently rose from 10 to 15 millimeters above the initial pressure.

Increasing the intragastric pressure to 150 millimeters or above frequently caused a sudden drop in the femoral pressure to approximately the initial mean pressure or even lower than this, while at the same time the pulse pressure suddenly disappeared. If at

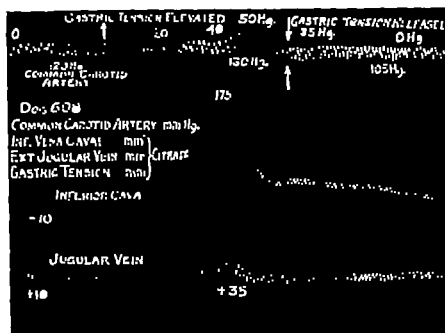


Fig. 3. The effect of intragastric tension upon carotid and superior and inferior caval pressures.

this time the femoral cannula was removed blood flowed slowly from the proximal portion of the artery without the characteristic spurts. The femoral pressure was maintained at this lowered level until the intragastric tension was released when the pressure immediately rose, frequently going above the initial value and at the same time there was a restoration of the pulse pressure. The transient rise in the femoral pressure when this occurred was followed by a rapid return to its original level.

The pressures in the carotid artery did not always parallel those in the femoral artery. With an intragastric pressure of 30 millimeters of mercury there was often a fall in the common carotid pressure similar to that observed in the femoral artery (Fig 3). This persisted until the intragastric pressure reached from 50 to 60 millimeters. Associated with the fall in the carotid pressure there occurred at times a decrease in the carotid pulse pressure.

Increasing the intragastric tension above 60 millimeters of mercury resulted in a rise of the carotid pressure to its original level. As the gastric pressure was further increased the carotid pressure rose above its initial level and there was frequently a marked increase in the pulse pressure while at the same time the femoral pulse pressure disappeared (Fig 3).

When the intragastric pressure was suddenly released the carotid pressure usually fell 10 to 15 millimeters below its original level. As a rule it then returned rapidly to its normal value and the pulse pressure became similar to that observed before the gastric pressure was increased.

In some experiments the initial fall in the carotid pressure was not observed as the intragastric tension was increased (Fig 4). Instead the carotid pressure rose while at the same time the pulse pressure frequently increased. The elevation in the carotid pressure was maintained until the increased intragastric tension was released.

#### DEDUCTIONS

The changes in the venous and arterial pressures are in many ways similar to the changes observed following increases in the intraperitoneal pressure. That these changes do have considerable effect on the cardiovascular system is beyond question.

The rise in the inferior caval pressure is undoubtedly due to local block of the inferior vena cava proximal to the point where the pressure was determined. Although we have not measured the portal pressure in these experiments we have observed that when the

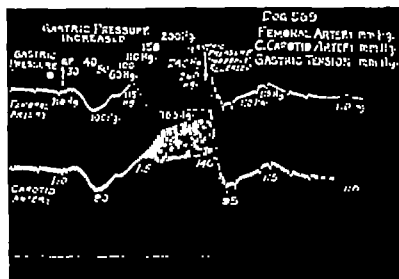


Fig. 3. The effect of intragastric tension upon the carotid and femoral pressures. Note the marked difference in these pressures when the intragastric tension reached 10 millimeters of mercury.

abdomen was rapidly opened after the intragastric pressure had been markedly increased there was definite evidence that the portal flow was also obstructed.

The series of events which took place as the intragastric pressure was increased may be given as follows. If considerable blood was forced from the area below the diaphragm into the heart, the common carotid pressure would increase while if the increasing intragastric pressure rapidly obstructed inferior caval and portal blood flow to the heart and the elevated diaphragm further limited the cardiac output, a temporary fall in arterial pressure would result.

The maintenance of the high inferior caval pressure was probably the result of several factors. In the first place the vascular bed distal to the obstruction may have within a very short time reached its maximum capacity or any increase in the size of this bed was rapidly taken care of by the blood forced into it from the arterial side. In the various discussions on the effect of intraperitoneal distention on the cardiovascular system no reference is made to the communications which exist between the arteries and veins above and below the diaphragm. That there is an extensive venous and arterial plexus of vessels nor

ally present in and around the vertebral column is beyond question. There is also the opportunity for communication between the intercostals and lumbar vessels and with the azygos vein. It may well be that at the highest venous pressure which we obtained certain of these pathways were opened sufficiently to prevent a further rise in the venous pressure.

The slight rise in the pressure in the superior vena cava may have been due to changes in the intrapleural pressure associated with the elevation of the diaphragm. It may also have been contributed to by an increased flow of venous blood through the various channels enumerated above resulting in an increased flow through the superior vena cava.

While the fall in the carotid and femoral arterial pressures may be explained on the reduced amount of blood available for the circulation as the result of the block below the diaphragm the subsequent rise in these pressures requires further explanation.

The rise in the arterial pressures when the intragastric tension was increased above 60 millimeters of mercury may in part have been due to vasoconstriction in the head, neck, and upper extremities, but it may also in part have been due to arterial blood carried to the

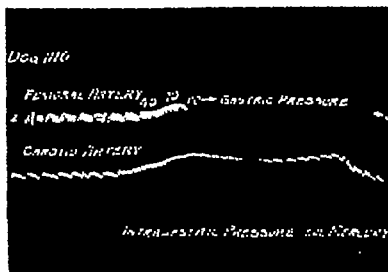


Fig. 4. The effect of intragastric tension upon caval and femoral pressures. In this experiment both pressures rose until the intragastric pressure reached 110 millimeters of mercury

inferior arterial circulation through vertebral anastomoses and to venous blood being carried from the inferior to the superior circulation

The sudden disappearance of the femoral pulse pressure was we think due to the arterial tamponade resulting from the greatly distended stomach which caused a markedly increased peripheral resistance just below the diaphragm. It may be thought that the tamponade at very high intragastric pressures caused complete aortic occlusion. If this were true the pressure in the vascular bed distal to the point of constriction was sufficient constantly to maintain a pressure of 90 millimeters of mercury. In the presence of the several minor pathways for venous return this would hardly seem probable. The fact that bleeding occurred from the proximal end of the femoral artery when the cannula was released in several instances is proof that in those experiments in which this occurred some blood was able to pass the point of tamponade and it is likely that some arterial blood constantly found its way into the area below the diaphragm through anatomic channels.

The marked increase in the carotid pulse pressure which was at times observed during the period of disappearance of the femoral pulse pressure may have been the result of mechanical factors causing an alteration in the dynamics of the superior circulation. At

this time the respiration is embarrassed by the greatly distended stomach which results in fixation of the low portion of the costal arch, and the heart occupies a more transverse position in the thorax. The aortic and carotid sinus reflexes play no part in this mechanism because it has been observed when the vagi were divided and the carotids ligated. The elevation of the pressure in the carotid at this period may also be influenced by tamponade of the abdominal aorta which acts to increase the peripheral resistance in the aorta.

The rapid return of the arterial and venous pressures to their original levels when gastric distention which had been maintained for only a short period was released is good reason for the early relief of gastric dilatation in the human. Bruns, Katz, and Kohn have observed that after the release of marked abdominal distention which had persisted for some time the fall in the arterial pressure was as much as 40 millimeters of mercury. They wisely caution that such a drop "in a feeble patient might result in death."

The rapid release of the intragastric pressure even when this had been maintained for only a short period resulted in profound changes in the arterial system. When the tamponade of the abdominal arterial and venous system is suddenly released, the readjustment of the circulation depends upon

the rapidity of the restoration of the normal factors controlling it

Of considerable importance in acute gastric dilatation is the added reduction of the blood volume. Large quantities of fluid and considerable amounts of salt may be lost through vomiting. This may further result in a shift in the acid base balance. Even when the tension is only moderately increased there must occur a considerable reduction in the blood volume as a result of the increasing venous pressure in the veins below the diaphragm. In a number of dogs bloody fluid was found in the stomach and intestines at the conclusion of the experiment. It is well known that portal obstruction results in a marked loss in the blood volume. This must be considerably greater when added to portal obstruction there occurs inferior caval tamponade.

Freeman, Monson and Sawyer have recently shown that acute dehydration stimulates medullo-adrenal secretion and Freeman had previously shown that adrenal secretion causes a still further reduction in the blood volume.

There results therefore a series of events which act in a vicious circle to cause a steady progression of symptoms once the mechanism of acute gastric dilatation is initiated. The mere replacement of the fluid vomited is insufficient to relieve the patient. Of primary importance is the release of the cause of the primary factor causing the circulatory changes. Of greater importance to the patient is the prevention of any increase in the intragastric tension by continuous gastric syphonage as suggested by Paine, Carlson and Wangensteen.

## CONCLUSIONS

1. Increases in the intragastric tension may cause profound changes in the cardiovascular system.
2. The inferior caval pressure progressively increased as the intragastric tension rose to 150 millimeters of mercury.
3. There resulted also an obstruction to the portal blood flow.
4. Marked changes are observed in the carotid and femoral blood pressure.
5. Evidence is presented to show that the distended stomach may cause tamponade of the abdominal aorta.
6. The primary cardiovascular effects are further exaggerated by the fluid lost by vomiting and into the intestinal tract.
7. The circulatory changes can only be prevented by preventing increases in the intragastric tension.

The authors wish to thank Dr. I. S. Ravdin for his constant interest and many helpful suggestions during the progress of the problem.

## BIBLIOGRAPHY

1. BRANT, W. A., KATT, L. N. and KOHN, N. *Am. J. Physiol.*, 935, citv. 30.
2. DMITRIENKO, L. F. *Am. J. Physiol.*, 924, liviii, 230.
3. FREEMAN, N. E. *Am. J. Physiol.*, 935, citv. 185.
4. FREEMAN, N., MORROW, R. S., and SAWYER, M. E. McKAY. *Am. J. Physiol.*, 935, citv. 658.
5. FREY, W. *Ztschr. f. d. ges. exper. Med.*, 912, xxxi, 40.
6. McIVER, M. A. *Ann. Surg.*, 927, lxxxv, 704.
7. PADDO, J. R., CARLSON, H. A. and WANGENSTEEN, O. H. *J. Am. M. Ass.*, 1933, c, 1920.
8. PLUMMER, L. *Arch. Internat. de physiol.*, 909, viii, 1.
9. RUMON, H. *Arch. f. Gynæk.*, 924, cxviii, 122.
10. THORNTON, J. M., and SCHMIDT, C. F. *Am. J. M.*  
8c. 93, citv. 580.

# THE DISAPPEARANCE OF BLOOD FROM THE CEREBROSPINAL FLUID IN TRAUMATIC SUBARACHNOID HÆMORRHAGE

## THE INEFFECTIVENESS OF REPEATED LUMBAR PUNCTURES

WILBUR SPRONG M.D. MONTREAL, CANADA

Department of Neurology and Neurosurgery McGill University and the Royal Victoria Hospital, Montreal

THE cerebrospinal fluid has, under normal conditions, a fairly constant composition. It contains no substances not present in blood plasma practically no colloid material, and very few cells. Red blood cells and fibrin are wholly foreign substances and Bagley has produced experimental evidence that blood in the subarachnoid space is at once harmful and may result in permanent meningeal and nerve tissue damage.

Repeated withdrawal of spinal fluid has been widely advocated for eliminating blood from the subarachnoid space. Patients with subarachnoid hæmorrhage treated by repeated lumbar punctures show a rapid disappearance of blood from the spinal fluid, and undue credit is easily given to the lumbar drainage overlooking the rôle of processes by which nature clears the subarachnoid space of foreign matter.

The purpose of this study has been to gather data on the disappearance of blood from the cerebrospinal fluid in traumatic cases and to determine the true value of repeated drainage of amounts of spinal fluid considered safe in traumatic cases in hastening the return of the fluid to its normal chemical and acellular state. The rate at which nature achieves this spontaneously and the effectiveness of repeated lumbar punctures are critically analyzed.

### METHODS OF INVESTIGATION

#### *Human cases of subarachnoid hæmorrhage*

A series of 15 cases<sup>1</sup> with blood in the spinal fluid were treated in three groups. Group I consisted of 5 cases which were given lumbar punctures once or twice a day with a sixteen gauge needle and the withdrawal of relatively large amounts of fluid. At the first puncture a radical reduction in pressure was always felt

to be unsafe and in no case was the pressure reduced to lower than two-thirds of its initial level in the horizontal position. In all subsequent punctures the pressure was reduced at least to one half. In this way from 15 to 37 cubic centimeters of fluid was removed daily. In 2 of these cases the pressure was consistently reduced to zero at each puncture after the first.

Group II consisted of 8 cases given daily lumbar punctures with a twenty-gauge standard needle or an 0.8 millimeter Labat's needle and the withdrawal of only 1 to 6 cubic centimeters of fluid.

Group III consisted of 2 cases in which a diagnostic puncture was performed on admission and a second puncture after 5 days in 1 and 6 days in the other.

From cell counts and the volume of the fluid obtained a fairly close estimate of the blood removed by each puncture was possible. The method used in treating these data is explained in detail in a subsequent analysis of a typical case.

*Animal experiments.* In order to amplify the data obtained in human cases where all determinations of blood in the cerebrospinal fluid are necessarily limited to spinal samples a series of 7 dogs were studied. Here it was possible to obtain all of the cerebrospinal fluid after various intervals following the introduction of measured amounts of blood into the subarachnoid space.

Each dog was anesthetized with either chloroform or amylal and a cisterna puncture performed. Two cubic centimeters of fresh blood from the saphenous vein were then injected slowly into the cisterna magna. A red cell count was made on the blood used in each case in order to estimate closely the number of corpuscles introduced. After intervals varying from 1 hour to 7 days all of the cerebrospinal fluid was removed as follows:

<sup>1</sup>Thirteen of these cases had traumatic subarachnoid hæmorrhage and were paraparetic.

TABLE I

Patient	Age	Estimated cerebrospinal fluid capacity	Number of punctures	Average daily removal of spinal fluid	Days required for fluid to clear	Initial red blood cell count, cells per mm.	Estimated amount of blood extravasated into cerebrospinal fluid		Amount of blood clotted by lumbar puncture		Percentage of estimated blood removed by punctures
		cc.		cc.			Number red blood cells	cc.	Number red blood cells	cc.	
P.V.	31	30	6	12	5	12,000	$1200 \times 10^6$	60	$241 \times 10^6$	97	11
E.D.		30		12	6	14,700	$4000 \times 10^6$	80	$418 \times 10^6$	68	18
M.R.		60	7	12	6	680,000	$68000 \times 10^6$	1.60	$16000 \times 10^6$	68	1
N.M.		100	8	12	6	100,000	$10000 \times 10^6$	1.30	$1350 \times 10^6$	69	21
J.R.	14	30	6	12	5	20,000	$27500 \times 10^6$	7.20	$241 \times 10^6$	21	4

Under chloroform or amylal anesthesia, a laminectomy was performed the caudal end of the spinal meningeal sac being exposed. This sac was tightly ligated near the tip well below the conus medullaris and cut free distal to the ligature. A venous cannula was then tied into this slender sac exactly as it would be tied into a vein. Thus a bloodless cannulation of the subarachnoid space was obtained with no possibility of fluid leak. By placing the animal in a vertical tail-down position with the nose elevated as high as possible and introducing air to displace the fluid the ventricles and subarachnoid space were completely drained. To be further assured that no appreciable fluid remained in the system a cisterna puncture was then performed and an excess of air injected until it escaped freely from the lumbar cannula.

Various fractions of the fluid were prepared for microscopic study by fixing the cells with iodine fumes shortly after the fluid was taken as advised by Kubie and Schultz.

#### RESULTS

*Human cases of traumatic subarachnoid hemorrhage.* A detailed analysis of the following case will illustrate the method used in analyzing the results of lumbar drainage and demonstrate the rapidity with which blood uniformly disappeared from the spinal fluid.

N.M. a 10 year old girl, was admitted to the Neurosurgical Service at the Royal Victoria Hospital following a blow on the head which resulted in an extensive skull fracture through the sagittal suture. There was no bleeding from ears, nose, or mouth. There was intermittent unconsciousness and vomiting for several hours following the accident and

complete dissociation of eye movements. No other localizing neurological signs were found. On admission the spinal fluid was grossly very bloody. Twelve cubic centimeters were removed. A small fraction obtained first and a similar final specimen were counted separately. The initial specimen contained 39,000 red cells per cubic millimeter while the last had 160,000. The greater concentration of cells in the last fluid obtained shows clearly that the source of the blood was not the lumbar puncture. The separate examination of the first few drops and the last few drops of fluid obtained eliminates the possibility of mistaking bloody fluid from a traumatic puncture for that arising from an intracranial hemorrhage. In this 10 year old girl the total cerebrospinal fluid capacity may be estimated to be about 100 cubic centimeters. A considerable error in this rough estimate would not change notably the relative values in the following calculations.

The estimated total one hundred cubic centimeters of cerebrospinal fluid in this patient on admission contained at least  $100 \times 1000 \times 160000$  or  $16000 \times 10^6$  red blood cells. At the first puncture  $12 \times 1000 \times 160000$  or  $1920 \times 10^6$  red cells were removed. Likewise the second puncture eliminated 15 cubic centimeters of fluid containing 25000 red blood cells per cubic millimeter or a total of  $375 \times 10^6$  red cells. In this way from the cell count and volume of each fluid specimen curve I, Figure 1 is obtained representing the rate of blood removal accomplished by repeated lumbar punctures.

The rate of actual disappearance of red cells determined by counting each specimen of fluid is represented in curve II, Figure 1. The tremendous discrepancy between curves I and II represents spontaneous elimination

\*Strong evidence was obtained by animal experiments described below that this estimate is actually only a small fraction of the blood actually extravasated.

TABLE II

Patient	Age	Estimated cerebrospinal fluid capacity	Number of punctures	Average daily removal of spinal fluid	Days required for fluid to clear	Initial red blood cell count, cells per c.mm.	Estimated amount of blood extravasated into cerebrospinal fluid		Amount of blood eliminated by lumbar punctures		Percentage of estimated blood removed by punctures
		c.cm.		c.cm.			Number red blood cells	c.cm.	Number red blood cells	c.cm.	
H.R.	48	150	6	3	6	14,500	8150 X 10 <sup>6</sup>	0.43	150 X 10 <sup>6</sup>	0.03	7
C.F.	30	150	6	3	6	37,000	4300 X 10 <sup>6</sup>	0.06	550 X 10 <sup>6</sup>	0.11	10
J.K.	12	130	6	6	5	800,000	60000 X 10 <sup>6</sup>	0.90	8000 X 10 <sup>6</sup>	1.78	9
C.C.	9	100	3	3	4	310,000	23000 X 10 <sup>6</sup>	4.90	1050 X 10 <sup>6</sup>	0.45	6
E.S.	13	150	6	3	3	11,500	3650 X 10 <sup>6</sup>	0.34	25 X 10 <sup>6</sup>	0.02	5
A.R.	54	150	6	3	6	27,500	3350 X 10 <sup>6</sup>	0.77	120 X 10 <sup>6</sup>	0.04	8
*E.W.	14	150	4	6	4	84,000	5000 X 10 <sup>6</sup>	0.7	401 X 10 <sup>6</sup>	0.08	11
*D.S.	17	150	6	4	6	25,500	3250 X 10 <sup>6</sup>	0.65	125 X 10 <sup>6</sup>	0.09	4

\*Blood in spinal fluid following craniotomy.  
All other cases were traumatic.

of cells. Similar curves for all other cases in this group show the futility of spinal punctures even more strikingly. Only from 4 to 22 per cent had been removed by lumbar drainage by the time the fluid had completely cleared.<sup>1</sup> Irregularities in curve II such as the rise to 57 000 cells on the third puncture, are perhaps due to small amounts of blood introduced by the puncture needle and only serve to diminish the discrepancy between the two curves representing spontaneous fluid clearance.

Table I summarizes the results on all cases in Group I. Even though as large amounts of spinal fluid were withdrawn as safety permits in each case it is clear that the value of lumbar punctures was negligible.

Table II presents a summary of results on cases in Group II. Here with the removal of only very small amounts of fluid all blood disappeared just as quickly as in Group I.

In the two additional cases which constituted Group III following a diagnostic puncture on admission, no further punctures were done until the fluid had cleared spontaneously.

For this study fluids were considered clear when the count became 500 red blood cells per cubic millimeter or less. At such a high dilution (1:10,000 of whole blood) the entire subarachnoid space and ventricular system would contain only 0.15 cubic centimeters or two-tenths of a drop of blood. However, if it is attempted to count punctures beyond this point with the number of red cells in literally zero, the slightest trauma from the puncture needle could easily introduce the negligibly small fraction of a drop of blood required to vitiate all value of further counts. This source of error had to be as carefully guarded against as possible in these determinations but, if present, it could only prolong the period required for the fluid to clear, causing an error "on the safe side" in demonstrating the rapidity with which cells disappear.

CASE 1 G V aged 12 years. On admission the spinal fluid contained 62 000 red blood cells per cubic millimeter. Six days later the second puncture was done and the spinal fluid was found clear and colorless and contained only 70 red blood cells per cubic millimeter and 20.1 milligrams per cent proteins.

CASE 2 M M aged 27 years. On admission the spinal fluid contained 26 500 red blood cells per cubic millimeter. When the second puncture was performed 5 days later the spinal fluid was clear and colorless and contained 30 red blood cells per cubic millimeter and 23.2 milligrams per cent total proteins.

Blood disappeared from the spinal fluid just as quickly in these cases without lumbar drainage as in those given repeated spinal punctures.

*Animal experiments.* The results of studies on 7 dogs including the amount of blood introduced into the subarachnoid space and the amount recovered after various intervals in the total cerebrospinal fluid, are summarized in Table III.

In 2 of this series of animals only 25 to 29 per cent of the red cells introduced into the subarachnoid space could be recovered in the total specimen of spinal fluid after an interval of from 60 to 90 minutes. Following this there was a fairly regular and rapid disappearance of cells until at the end of 7 days 99.8 had been



TABLE III

Dog No.	Blood count (million cells per mm.)	Ccm. of blood injected	Interval of time before drainage of all cerebrospinal fluid	Ccm. of cerebrospinal fluid obtained	Cerebrospinal fluid count (red cells per mm.)	Total number of cells introduced ( $\times 10^6$ )	Total number of cells recovered ( $\times 10^6$ )	Percentage of injected blood recovered in spinal fluid	Percentage of injected blood which disappeared spontaneously
	7.5		hr	8.5	270,000	5,000	4,300	79	7
1	8		15 hr	30	400,000	5,000	4,000	80	7
2	2		20 hr	30	75,000	10,000	1,400	14	86
3	6.3		48 hr	9	87,000	1,500	783	52	91
4	7		3 days	0	4,700	14,000	41	3+	99+
5	6.9		3 days	3	100	3,800	30	8-	98+
7	6.3		7 days	0	2,000	4,600	26		99.8

## COMMENTS

spontaneously eliminated. A curve (Fig. 3) representing graphically this daily diminution in red cells shows a striking resemblance to curves plotted from daily cell counts on the spinal fluid of human cases of subarachnoid hemorrhage (Figs. 1 and 2).

In each case treated by repeated lumbar puncture and the withdrawal of as much cerebrospinal fluid as seemed safe, the amount of blood eliminated divided by the estimated amount initially extravasated gave a fraction ranging in value from one tenth to one fifth. The numerator of the fraction may be regarded as an accurate approximation since it was determined from actual cell counts and the measured volume of fluid obtained. On the other hand the denominator is much too small. This is true because the lumbar sample from which the free blood in the total cerebrospinal fluid is calculated contains a much smaller concentration of cells than the fluid near the site of hemorrhage. Sachs et al. have commented on the slow and uneven diffusion which occurs in the spinal fluid. The cells freely suspended in the cerebrospinal fluid throughout the entire subarachnoid space represent only a fraction of those extravasated since many are promptly bound in a clot or entangled in the meshes of the arachnoid trabeculae.

A rough idea of the factor by which this denominator should be multiplied to get a truer estimate of the total blood in suspension was obtained experimentally in dog 1 of the animal series. In this animal the cerebrospinal

fluid was all withdrawn 20 hours after a known quantity of blood was introduced into the subarachnoid space. This interval should allow for maximal diffusion of cells to the lumbar region. The first 40 per cent of the fluid obtained was collected separately and may be assumed to be comparable to the lumbar samples dealt with in human cases. The probable error in this assumption is clearly on the side of minimizing the difference between the spinal specimen and the total fluid since never can so much as 40 per cent of the cerebrospinal fluid be obtained without displacing some of it with air. In this animal the first 40 per cent of fluid contained 21,000 red blood cells per cubic millimeter whereas the total specimen contained 72,000.

A general impression of the share of extravasated blood which is soon fixed and cannot be recovered even if all the cerebrospinal fluid is withdrawn was obtained experimentally in dogs 2 and 3. In dog 2 only 29 per cent of the blood introduced was found in the fluid 1 hour later and in dog 3 only 25 per cent after 90 minutes. In dog 1 then the total fluid contained in suspension about 3.5 times as many cells as might be estimated from the lumbar specimen and in dogs 2 and 3 the total blood free in the cerebrospinal fluid represented only 25 to 29 per cent of that originally introduced. In these animals the cell count in the spinal sample of fluid might be multiplied by about twelve and a truer estimate of the subarachnoid blood obtained. It is fair to assume from these experiments that in human cases the estimate of total subarachnoid blood from the

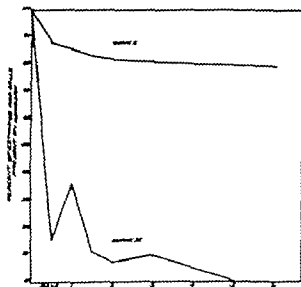


Fig. 1. Typical curves showing the futility of repeated lumbar punctures in eliminating blood from the cerebrospinal fluid in a case of extensive traumatic subarachnoid hemorrhage. Case N. M. Curve I represents the elimination of red blood cells from the cerebrospinal fluid accomplished by repeated lumbar punctures. Curve II represents the actual disappearance of red blood cells as shown by cell counts on each specimen of fluid. The enormous discrepancy between the two curves represents spontaneous clearing of the cerebrospinal fluid.

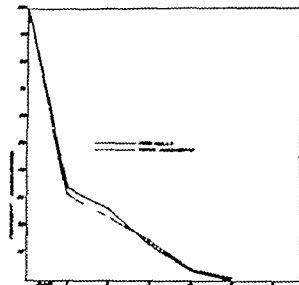


Fig. 2. Curves showing the rapid spontaneous disappearance of blood cells and excess proteins from the cerebrospinal fluid in a case of extensive traumatic subarachnoid hemorrhage. Case J. K. The solid line curve represents the disappearance of red blood cells from the cerebrospinal fluid as shown by cell counts on the fluid obtained by daily small diagnostic lumbar punctures. The broken line curve represents the elimination of proteins. In 5 days the red cells were reduced from 800,000 to 300 per cubic millimeter and the proteins dropped from 3966 to 48 milligrams per cent.

lumbar sample of fluid is likewise many times too small.<sup>1</sup>

In the second group of cases in which the fluid withdrawn was always limited to from 1 to 5 cubic centimeters the spinal fluid was clear in the usual 4 to 6 day interval required in the previous group of cases treated with more extensive fluid withdrawals. In 2 cases of this series the protein content of each specimen of fluid was determined. In each instance the spontaneous elimination of excess proteins was strikingly parallel with red cell disappearance, normal values being established within 6 days in each case (Fig. 2).

Each one of the multiple punctures in Group I was performed with a large needle in the hope that spinal fluid leakage would continue through the puncture openings in the

dura. Yet the rate of clearing was just as rapid in Group II where the needle used was very small. The negligible importance of continuous fluid leakage is further emphasized by the fact that the rate was still unchanged in

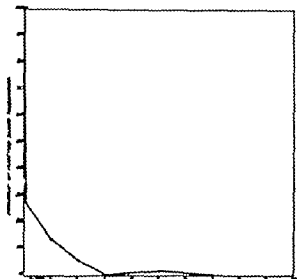


Fig. 3. A composite curve showing the rate of cerebrospinal fluid clearance in a series of dogs in which all of the cerebrospinal fluid was withdrawn at various intervals following the introduction of measured amounts of blood into the subarachnoid space.

<sup>1</sup>This is clearly confirmed by cell counts on the spinal fluid of post-operative cases as illustrated by the following case: D. S. the day following an extensive cortical exploration with the removal of a large scirrhous area of cortex was found to have 1,500 red blood cells per cubic millimeter in the spinal fluid. Assuming that the heparin specimen was a true sample and that he had a total of 150 cubic centimeters of cerebrospinal fluid the total blood would be computed to be about .8 cubic centimeter or only 8 drops. There is no chance of measuring the actual blood introduced by such an operation but any surgeon would at once agree that it would amount to at least several centimeters with the most perfect hemostasis obtainable.

the 2 cases in which blood elimination was left wholly to spontaneous processes

To Easick, Weed, Woolard, and Kubie and Schultz we owe a great deal of information regarding the phagocytosis of particulate matter (e.g. carbon particles, trypan blue granules, and red cells) within the subarachnoid space. These workers have demonstrated an active physiological mechanism for the spontaneous clearing of cerebrospinal fluid but in each instance their attention was confined to the origin character and activity of phagocytic cells. No quantitative data were obtained therefore regarding the rate of red cell destruction following hemorrhage or the introduction of known amounts of normal blood.

A day following the introduction of blood in animals of the present series, polymorphonuclear leucocytes appeared in considerable numbers. In 3 days lymphocytes and monocytes were predominant. In 5 days, when only 0.3 per cent of the injected blood remained in the fluid numerous mononuclear phagocytes were seen engorged with red cell debris which stained heavily with special iron stains. Their abundance was sufficient to indicate strongly that their activity may play a major part in cerebrospinal fluid clearance

#### SUMMARY

Blood disappears within 5 or 6 days from the spinal fluid. This period is not influenced by the use of repeated lumbar punctures. Xanthochromatin which makes its gross appearance usually on the second or third day following a subarachnoid hemorrhage is entirely absent or reduced to a faint trace in 6 days with or without lumbar punctures. The spinal fluid obtained always represents a high dilution of blood and only a small fraction of

the total fluid can be removed at one time with safety. Therefore the amount of blood eliminated by lumbar drainage is always amazingly small. In no case studied in the present investigation was more than 10 drops of whole blood removed by an entire series of punctures.

The rate at which blood bearing fluid can be withdrawn from the subarachnoid space necessarily is limited to the rate of secretion of fresh fluid. This is far too slow to rival the rapid spontaneous elimination of red cells so that only a negligible fraction of subarachnoid blood can be removed by repeated withdrawal of spinal fluid by the time fluid clearance takes place.

Lumbar punctures should be used in traumatic cases for diagnosis and reducing abnormal pressure, but are entirely futile as a means of hastening the disappearance of blood from the cerebrospinal fluid.

I gratefully acknowledge my indebtedness to Dr. William Cooce for generous help and advice in the present study.

#### BIBLIOGRAPHY

1. BAGLEY, C., JR. Blood in the cerebrospinal fluid, resultant functional and organic alterations in the central nervous system; experimental data. *Arch. Surg.* 92, xvii, 28-38.
2. EASICK, C. R. Formation of macrophages by the cells lining the subarachnoid cavity in response to the stimulus of particulate matter. *Contrib. to Embryol.* No. 42. Carnegie Inst. Washington, Publ. No. 272, 377, 1930.
3. KUBIE, L. S., and SCHULTZ, G. M. Vital staining of the cells of the cerebrospinal fluid and the meninges in cats. *Johns Hopkins Hosp. Bull.*, 1925, xxxviii, 91.
4. SANCHEZ, E., WILKINS, H., and SANCHEZ, C. F. Studies on cerebrospinal circulation by a new method. *Tr. Am. Neurol. Ass.*, 1929, 252.
5. WOOD, L. H. The cells of the arachnoid. *Johns Hopkins Hosp. Bull.*, 1930, xxxi, 343.
6. WOOLARD, H. H. Vital staining of the leptomeninges. *J. Anat.*, 924, lviii, 89.

## CARBON DIOXIDE, THE GASEOUS ANÆSTHETICS, AND THE ADVANTAGES OF REBREATHING METHODS OF THEIR ADMINISTRATION

JAMES G POE, M.D., DALLAS, TEXAS  
*Anesthesiologist, Baylor University Hospital*

CARBON dioxide, instead of being only a waste product to be exhaled through the lungs and a factor in the acidbase balance plays the rôle of a respiratory stimulant. It regulates the heart, affecting both the rate and rhythm and indirectly the vascular system sustaining the blood pressure. It also maintains peristalsis of the alimentary tract, affects the mental equilibrium, and promotes systemic oxidation by increasing the disassociation of oxygen from the hæmoglobin of the blood. Thus the rôle it plays in supporting these important bodily functions makes it about equal in importance to the supply of oxygen, and indeed, without its stimulating effects upon the respiratory center, normal respiration would be impossible.

If we rebreathe the pure oxygen into a bag hyperpnœa soon occurs from the carbon dioxide accumulated therein, thus proving that oxygen want was not the cause of the excessive breathing.

If we voluntarily breathe fast and deeply for several minutes, thus eliminating carbon dioxide from the system, the desire to breathe will be suspended, even until cyanosis may appear and also fatal apnœa may result. Forced artificial respiration performed vigorously on animals for 15 to 20 minutes, may produce a fatal apnœa from the acapnia thus induced, and after 8 or 9 minutes death usually results from lack of oxygen.

During ether induction when associated with prolonged excitement and hyperpnœa, dogs will often die from apnœa when anæsthesia is completed, there being an insufficient amount of carbon dioxide remaining in the system to stimulate the anæsthetized respiratory center.

Excessive pain from injuries through inducing hyperpnœa and acapnia may result in fatal apnœa when the pain is relieved by open ether anæsthesia, there being no means thus

afforded of conserving the carbon dioxide in the system. To offset this danger in those that were severely injured, the ancients partly smothered their patients.

The importance of carbon dioxide and its many vital functions requires that it shall be constant in quantity in the system, hence we find in each individual that there is practically no variation from day to day under normal circumstances.

The alveolar air contains as an average about  $5\frac{1}{2}$  volumes per cent of carbon dioxide. Normal respiration does not disturb the relative proportion of the gaseous contents of the alveolar air, as only about 350 cubic centimeters of the tidal air reaches the stationary alveolar air and then intermixes with the latter by diffusion and thus is normal tranquil respiration maintained and also the other important functions performed in a regular manner. So delicate is this regulatory mechanism of the respiration performed that even the thought of it disturbs it in an individual, as we cannot breathe regularly if we give it our attention.

If carbon dioxide is added to the inspired air by rebreathing or otherwise or it is exhaled into the lungs from the blood more freely than normal as during muscular exercise, respiratory stimulation at once occurs. If 4 or 5 per cent of carbon dioxide is added to the inspired air, or if 0.2 per cent is added to the constant alveolar air, the respiratory efforts will be stimulated to double the normal volume of ventilation. If pure oxygen is breathed instead of air practically no change in the respiration occurs and furthermore, if the hæmoglobin of the blood is normally saturated, the corpuscles cannot take any more of the oxygen, and only a small quantity of it can be added to the blood by being dissolved in the plasma when some pressure is applied. Therefore, hyperpnœa depletes the

the 2 cases in which blood elimination was left wholly to spontaneous processes

To Essick Weed, Woolard and Kubie and Schultz we owe a great deal of information regarding the phagocytosis of particulate matter (e.g. carbon particles, trypan blue granules, and red cells) within the subarachnoid space. These workers have demonstrated an active physiological mechanism for the spontaneous clearing of cerebrospinal fluid but in each instance their attention was confined to the origin character and activity of phagocytic cells. No quantitative data were obtained therefore regarding the rate of red cell destruction following hemorrhage or the introduction of known amounts of normal blood.

A day following the introduction of blood in animals of the present series polymorphonuclear leucocytes appeared in considerable numbers. In 3 days lymphocytes and monocytes were predominant. In 5 days, when only 0.3 per cent of the injected blood remained in the fluid, numerous mononuclear phagocytes were seen engorged with red cell debris which stained heavily with special iron stains. Their abundance was sufficient to indicate strongly that their activity may play a major part in cerebrospinal fluid clearance.

#### SUMMARY

Blood disappears within 5 or 6 days from the spinal fluid. This period is not influenced by the use of repeated lumbar punctures. Xanthochromatin which makes its gross appearance usually on the second or third day following a subarachnoid hemorrhage is entirely absent or reduced to a faint trace in 6 days with or without lumbar punctures. The spinal fluid obtained always represents a high dilution of blood and only a small fraction of

the total fluid can be removed at one time with safety. Therefore the amount of blood eliminated by lumbar drainage is always amazingly small. In no case studied in the present investigation was more than 10 drops of whole blood removed by an entire series of punctures.

The rate at which blood bearing fluid can be withdrawn from the subarachnoid space necessarily is limited to the rate of secretion of fresh fluid. This is far too slow to rival the rapid spontaneous elimination of red cells so that only a negligible fraction of subarachnoid blood can be removed by repeated withdrawal of spinal fluid by the time fluid clearance takes place.

Lumbar punctures should be used in traumatic cases for diagnosis and reducing abnormal pressure but are entirely futile as a means of hastening the disappearance of blood from the cerebrospinal fluid.

I gratefully acknowledge my indebtedness to Dr. William Cose for generous help and advice in the present study.

#### BIBLIOGRAPHY

1. BAGLEY, C., JR. Blood in the cerebrospinal fluid, resultant functional and organic alterations in the central nervous system, experimental data. *Arch. Surg.* 1928, *xviii*, 18-35.
2. LADD, C. R. Formation of macrophages by the cells lining the subarachnoid cavity in response to the stimulus of particulate matter. *Contrib. to Embryol.* No. 42, Carnegie Inst. Washington, Publ. No. 572, 377 1930.
3. KUMAR, L. S., and SCHULTZ, G. M. Vital staining of the cells of the cerebrospinal fluid and the meninges in cats. *Johns Hopkins Hosp. Bull.*, 1935, *xxxviii*, 91.
4. SACCA, E., WILKINS, H. and SAGE, C. P. Studies on cerebrospinal circulation by a new method. *Tr. Am. Neurol. Ass.*, 1929, 252.
5. WOOD, L. H. The cells of the arachnoid. *Johns Hopkins Hosp. Bull.*, 1930, *xxxii*, 343.
6. WOOLARD, H. H. Vital staining of the leptomeninges. *J. Anat.* 1924, *lviii*, 89.

little or no harmful effects on the blood and tissues. When used early in the operation for relaxation, patients are often unaware that ether has been used with the gases.

The special effectiveness of relatively small amounts of ether and the rapid recovery from it when administered by the closed method is well recognized. It has therefore, a great advantage over ether anæsthesia by the open method.

The apparent simplicity of open methods with a small mask being the only apparatus required for the administration, and through the lack of a sufficient number of anæsthetists properly trained to use closed methods it appears that open ether anæsthesia must unfortunately still be the dependence, especially in the smaller hospitals, for some time to come. Some surgeons still prefer it however, as they are accustomed to this type of anæsthesia and relaxation.

Factors that tend to prevent acapnia and resultant apnoea with the so called open method are: (a) It is not strictly open, for the mask when covered with towels, etc., retains the latter portion of the air exhaled and this air especially rich in carbon dioxide is inhaled again and thus a degree of rebreathing is afforded that in most cases is quite sufficient. (b) Morphine premedication prevents over stimulation of respiration as from pain etc. and (c) often a continuous partially obstructed respiration so that the free elimination of carbon dioxide is prevented. (d) The brevity of the operation together with the added stimulating effects of ether on the respiration all act as preventives of apnoea and shallow breathing the most common and troublesome features of the open method of administration.

In the administration of ether if the different stages of narcosis (as now taught) are observed and the depth of the anæsthesia is varied to meet the requirements of each operation and as the technique will permit much will be accomplished in conserving the vitality of the patient and in preventing unnecessary overanæsthetizing. Anæsthesia sufficiently deep for an intra abdominal operation might prove fatal in the case of a very sick mastoid patient in whom only the primary stage is required.

When acapnia with limited respiration develops, a rubber tube from the carbon dioxide tank may be placed under the open mask and a small amount of carbon dioxide liberated to be inhaled with only two or three breaths. Respiration at once becomes increased in rate and depth and a threatened period of apnoea or retching may be averted. The respiration also improves generally induction may be hastened and later ether may be readily eliminated.

Other special advantages of carbon dioxide and complete rebreathing methods are that the use of ethylene as an anæsthetic is rendered safe from static ignition. The cautery also can be used with safety for the amount of ethylene escaping into the operating room is restricted thus differing materially from the fractional rebreathing method in which a portion of each exhalation is discharged into the room. The full deep breathing maintained by carbon dioxide and rebreathing throughout the operation lessens the incidence of post operative pulmonary complications and promotes full oxidation. Furthermore this method permits of the use of morphine, sodium amytal and other useful narcotics as pre operative medication without the danger of respiratory depression that might otherwise occur and render their use hazardous. Without premedication with morphine or other narcotics to depress the respiratory center, rebreathing with resultant hypercapnia may overexercise breathing. The bag must then be occasionally partially emptied and refilled with fresh gases to relieve the hyperpnoea.

As special factors safeguarding ethylene from ignition from the cautery, static electricity, etc. I will again refer to complete rebreathing complete except for a degree of leakage that slowly occurs and requires the addition of fresh gases from time to time thus effectively preventing overbreathing. The leakage is slow enough however effectively to prevent the ethylene from accumulating in an unsafe and detectable quantity in the operating room. With proper room ventilation and by further safeguarding by the use of a wet towel draped over the face piece we use the cautery for hemorrhoids and such operations as freely as desired.

## HISTOPATHOLOGY OF ENDOCERVICITIS

The cervix uteri assumes altered pathological states as a result of various etiological factors chief of which are the traumas and lacerations of labor with consequent infections. Microscopically in the early stages of inflammation the most important changes would be hyperplasia and hypertrophy of the cells in lining squamous epithelium and glands metaplasia of the columnar cells of the columnar epithelium and the glands, and downward growth of the widened epithelium into the stroma. The vasculature becomes engorged and there is evident a zone of lymphocytic cells under the basement membrane and penetrating upward into the cellular epithelium. The lining cells, including those in the glands at first might show an orderly arrangement and appear hypertrophic and hyperplastic. Later more abnormal changes develop and produce the confusing pictures suggestive of 'precancer' or cancer. These stages do not proceed in an orderly progressive fashion as just described but merge one into the other thus there might be all grades of inflammation in one and the same cervix or in one and the same field observed under the microscope.

Briefly, the cells in the aggravated stages of cervicitis might be hypertrophic, vary in size and shape, be multinucleated, show amitosis, hyperchromatism of the nuclei and an altered nuclear plasma relationship. Some giant cells may be seen and in some situations the cells penetrate downward into the stroma and overgrow other tissues. Most of these abnormalities are also present in established cancer yet such affected tissues might be stamped as "precancerous" or suspicious others would label them as cancerous (see Figs. 1 to 14 inclusive).

In the literature the terms incipient cancer 'beginning cancer' and precancer are loosely applied and in many cases are made to appear synonymous. This conception is wrong because incipient or beginning cancer can mean only established cancer although in its earliest stage, while precancer presumes only the future probability of cancer developing. Not every case of precancer turns into cancer later as some remain stationary.

## DIFFICULTIES IN THE FORMULATION OF PRECANCER 'CRITERIA

A glance at the recognized criteria of established cancer does not clarify the situation as to the differential diagnosis of "precancer." Ewing presents the following attributes of cancer with the qualification that any one or all of which may be present" (1) abnormal cellular overgrowth (2) atypical qualities of the cells (increased nuclear content of nucleus alterations in size of cells, hyperplasia, excessive or atypical mitosis degenerative nuclear and cytoplasmic changes), (3) heterotopia (4) local invasive or destructive properties (5) desmoplastic properties (6) loss of polarity (7) metastases.

The most accepted ideas of incipient cancer seem to lay stress on the abnormal cell morphology. Thus Schauenstein Schottlaender Ewing and Rublin find that the characteristics of incipient carcinoma are as follows: (1) irregular arrangement of cells (2) loss of cell boundary (3) abnormally close juxtaposition of cells (4) changes in chromatin network (5) changes in protoplasm toward stains (eosinophilia).

As mentioned above cancer can be diagnosed microscopically even when only one of Ewing's criteria are present and yet that criterion may be the feature of a tissue that is still in the *precancerous stage*. There seems to be an intermingling and common basis in some of the criteria of precancer and cancer although of course the histological structures of the two conditions are different.

The most frequent findings common to both precancer and cancer are in order of importance (1) atypical cellular changes (2) abnormal cellular overgrowth, (3) heterotopia (4) loss of polarity.

When one studies any single accepted criterion of cancer there is a doubt left as to the minimum amount of abnormality that must be present to eliminate the precancer stage in a suspicious piece of tissue. Theoretically if one finds the same type of cellular changes in the two stages of precancer and cancer all precancers should be labelled as actually cancerous even if only one cancer like cell is demonstrated histologically. Practically of course this is not so.



Fig. 1. Section of cervix of patient aged 34 years, showing papilloma. Very low power. Note the extraordinary broadening of the squamous layers, the epithelium being about six times as wide as the normal lining. A. Upper border of squamous epithelium, B. lower border, C. over shadowed stroma, D. hornification.

Lacking an absolute and unequivocal histological dividing point between the two conditions, we are forced from the evidence at hand to believe that cancer is an intensification or follow up stage of precancer. One should not believe that an increased number of suspicious attributes in a piece of tissue makes that tissue cancerous just as typhoid is diagnosed from a number of relatively mild symptoms. This would seem to be the policy of some observers, however.

The lack of a formal and precise description of precancer has caused certain observers to doubt the possibility of diagnosing this stage microscopically, and thus they lean toward the idea of a tissue being either actually cancerous when any of the attributes of cancer are present or non-cancerous otherwise. Thus Frank doubts the possibility of diagnosing early cancer in conditions which lacking as we do absolute histological criteria of early malignancy may as well prove to be harmless epithelial proliferation. Keller and Van de Vyver agree with Schiller (17) that it is not possible to diagnose microscopically a precancer state, and that many so-called precancers are really established cancers. Robert Meyer believes that as soon as a tissue possesses a single criterion of malignancy that tissue is no longer precancerous. He would

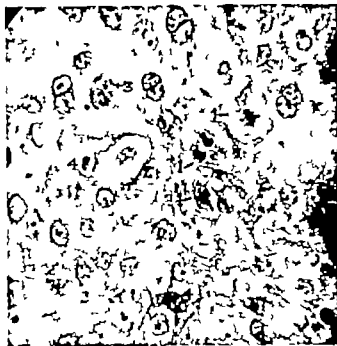


Fig. 2. Oil immersion study of blocked area in Figure 1. Abnormal cytology of the squamous epithelium. 1. Mitotic figures, 2. giant cell, 3. multinucleated cell, 4. hyperchromatic cell. Note the fairly normal cells interspersed between the cancer like cells.

call precancerous those cellular changes which take place in the interior of the cell and which are not visible under the microscope and can not give a special histological morphology.

#### EARLIEST CANCER DIAGNOSIS IN ITS RELATION TO 'PRECANCER'

Are cellular changes alone sufficient to establish carcinoma diagnosis? Several investigators quoted by Stone have observed in the uterus that a certain type of early cancer spreads superficially over wide areas before showing marked invasive features. Broders emphasizes that carcinoma or cancer regardless of etiology is a primary disease of epithelial cells and that all other phases and sequelae although of great importance are in reality of secondary nature. Further on in his paper he notes that the diagnosis of carcinoma *in situ* as of carcinoma in general is based chiefly on altered cellular characteristics in contradistinction to the cellular situation. The nuclei as compared with those of normal cells have an increased avidity for the basophilic dyes are usually increased in size both actually and in relation to the cytoplasm, are frequently irregular, are not infrequently



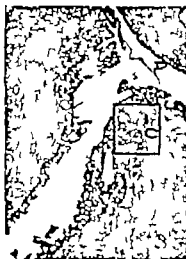


Fig. 3.



Fig. 4.



Fig. 5.

Fig. 3. Section of cervix of woman aged 40 years. Low power. Excessive atypical overgrowth of new squamous cells along the walls of a large duct, penetrating into glands and overcoming them, and also dipping down into the stroma. At A and B a view is given of the beginning of the process with new cells piling up under the columnar epithelium normally lining the duct. Further up at C is the increasing stratification in glands and stroma. The unaffected duct lining is well shown at D.

Fig. 4. High power view of area blocked off in Figure 3. The prickly cells are shown at A, the flat desquamating cells at B, and the intact basement membrane at C. The

cells are somewhat modified and are excessive in quantity. There is no loss of polarity and the presence of uniformity in the cells also rules out cancer. Picture is that of a carcinoma condition.

Fig. 5. Section of cervix in woman aged 40 years. New cells of epidermalization growing in between two glands. The cells are modified in character, only slightly resembling stratified squamous epithelium; they are loosely arranged and irregular, and there is no basement membrane. A represents the edge and denotes the absent basement membrane; B the columnar epithelium lining the glands; C the atypical cells. There is too much regularity in this picture to call it anything but a carcinoma condition.

in a state of atypical or pathological mitosis, and are occasionally observed in groups in the form of tumor giant cells.

He discounts the importance of penetration of the epithelial cells past the basement membrane as a diagnosis of carcinoma, but stresses above all else the type of lining cells even when within the basement membrane confines, as the final arbiter of malignancy. His discussion of characteristic malignant attributes of the cells fits in fairly closely with those changes observed in the severest cases of cervicitis, but which cannot be definitely classed as cancerous by any means. These cellular changes seem to disagree only in a matter of quantity from those in actual cancer (see Figs. 1 to 14 inclusive).

Stone believes that the positive identification of a malignant neoplasm cannot be made histologically until definite destructive capacity is recognized, although paradoxically he points out that a certain type of early cancer spreads superficially over wide areas before

showing marked invasive features. Ewing while certain that beginning carcinoma can be diagnosed from marked cellular changes, believes that there can be no room for doubt if the features of downward growth and heterotopia are added. Rubin does not accept the deep invasion of the neoplastic cervical surface epithelium into well marked inflammatory stroma as pathognomonic for the presence of a carcinomatous process. His conclusion is that the important criteria of malignancy in these early cases lie not so much in the relation of the cell nests to the stroma, the depth or extent of epithelial invasion or evidences of surrounding inflammatory changes, as in the intrinsic morphology of the epithelial cells."

Villard and Montel attempt to prove the sequence between inflammation and cancer in a cervix by the appearance on one lip of a hyperplastic metritis, and on the other lip—incipient cancer point of transition and the precancer stage. They also note that it is pos-



Fig 6

Fig. 6. Section of cervix in woman aged 33 years. Epithelization of gland through excessive downgrowth of surface squamous epithelium. At 1 marked proliferation of squamous cells with rupture through basement membrane.



Fig 7

Fig. 7. High power view of area blocked off in Figure 6. The stratified squamous cells, C have assumed an abnormal appearance and there is loss of the basement membrane at B. D represents the gland lumen. The field is a carcinoid one.



Fig 8

Fig. 8. Section of cervix of woman aged 61 years. Paps of hyperplastic squamous epithelium dipping down deeply into the stroma A.

sible to disclose in the flat epithelium the most extreme beginning of that which can be a cancer before infiltration in the depth, before any clinical signs of malignancy are apparent.

Keller and Van de Vyver warn against the possibility of a precancerous state being interpreted when a precocious stage of cancer is really present. They are quite certain that the absence of deep penetration cannot be interpreted against the existence of cancer. They believe that many early cancers show nothing but a modification of the superficial epithelial layers without deep penetration even after serial section study.

The opinion of Lubarsch is that cancer should be diagnosed only "when one has found sure and clear criteria of destructive growth."

As previously mentioned, Robert Meyer (11-12) believes that as soon as a tissue possesses a single criterion of malignancy, that tissue is no longer precancerous.

Novak after distinguishing the deep penetration of squamous epithelium in the inflammatory cervix from actual cancer by the fact that in inflammation the invasion of the depths by creepers of squamous epithelium proceeds along the trellis furnished by the inflamed framework while the penetration of

actual cancer is a more ruthless and less orderly one notes "After all however the differentiation of these inflammatory lesions from very early cancer is based upon the study of the cells themselves rather than upon such differences in general architecture as have been discussed. He would differentiate the benign lesion by the fact that it is only the

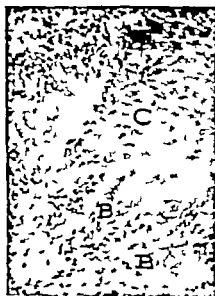


Fig. 9. High power view of blocked area in Figure 8. B. Absent basement membrane region. C. slightly modified squamous cells. This is a good example of heterotopia in a benign piece of tissue.



Fig. 6. Low power photomicrograph of cervix. Excessive growth of the stratified squamous epithelium which is arranged in alveolar fashion.

basal cells of the epithelium which are arranged perpendicularly to the basement membrane like palisades, while in carcinoma this perpendicularity is often noted in the upper layers as well.

As previously described Martzloff demonstrates in leucoplakia of the cervix the cytology commonly encountered in a well developed cancer of the cervix. He insists that such a histological picture lacks one anatomical requisite invasion to make it a carcinoma.

Schiller (18) in a masterly article on early diagnosis of cancer of the cervix, describes how most of these cancers are separated from the normal tissue by a definite zone of atypical tissue of about the same width as the normal epithelium. This is called the carcinomatous layer and according to him, represents the first stage of the development of actual carcinoma. The earliest cervical cancers would be represented by nothing but a layer of altered cells (staining white with Lugol's iodine in contrast to the mahogany brown of the normal cervical tissue) later there would be beginning downgrowth, until finally we would have advanced downgrowth and superficial ulceration in addition to this superficial layer. This carcinomatous layer is diagnosed as cancer solely by its altered cytology and he points

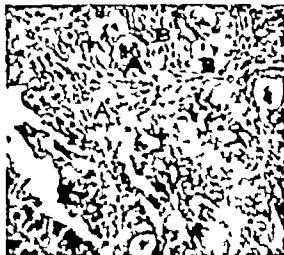


Fig. 7. High power view of blocked region in Figure 6. The alveoli are filled with a basal type of cell. *B* Basement membranes. *B* are intact.

out that "from the old and antiquated point of view carcinoma is diagnosed only when it penetrates deeply." The youngest carcinoma diagnosed by him measured 2 to 3 millimeters in diameter and presented such cellular changes with no downgrowth or metastases.

The cytology of this carcinomatous layer is described as follows: "Polymorphic and atypical cells especially as regards the nuclei. Large nuclei may be surrounded by small ones, dark nuclei may be next to light nuclei, and occasionally giant cells may be found with several nuclei in one cell. The great number of nuclei is extraordinary there being more nuclei than in the healthy epithelium. The regular order as seen in normal epithelium is absent. In healthy epithelium the number of nuclei diminishes centrifugally from basal layer to the surface until in the superficial layer only a few shrunken nuclei living in large cell alveoli are found. In the presence of a carcinomatous layer however we find on the surface a great number of dark nuclei living close to one another. The basal layer is sharply demarcated against the underlying connective tissue and never shows projecting single cells or groups of cells." He notes that occasionally one can see within the normal tissue near the borderline single dark cells which from a morphological point of view are characteristic of carcinoma (see Fig. 15).

He notes also as a characteristic of this carcinomatous epithelium that "the superficial layer which in normal epithelium consists of large vesicular light cells with small shrunken nuclei or nests of nuclei is missing. This superficial layer which is typical in the epithelium of the cervix—normally the epithelium of the cervix does not show parakeratosis—is filled with glycogen as proved by staining.

He describes how Bowen's precancerous dermatoses were originally diagnosed as such because there was no downgrowth and only altered cellular epithelium. Study later revealed that downgrowth would develop in time so that these dermatoses were really actually cancerous at the time there were only cellular changes present. Schiller dismisses the term 'precancerous' as being too ambiguous.

It is interesting to note in some of the sections (Figs 2, 4, 7, 14) how closely the cells approach in type those found in established cancer. In several cases the cells in certain spots are actually cancerous in appearance.

#### THE CANCER CELL STRUCTURE IN ITS RELATION TO "PRECANCER"

There does not seem to be any doubt that cancer can be diagnosed from cell changes alone—even when no other criteria of cancer are present. The cancer cell itself when studied intimately presents definite signs as compared to the normal cell. The nucleus may show an increased chromatin content and abnormal mitosis either in the form of increased or atypical mitosis. The nuclear protoplasmic ratio is altered, the nucleus and nucleolus being increased in size relatively as to the rest of the cell (MacCarty) (see Figs. 15 and 16).

In respect to the significance of mitotic figures, Novak after reminding one that regeneration normally takes place from the basal layer remarks that mitoses are almost never seen in this layer under normal conditions or even in inflammatory lesions. According to him they are even more rare in the superficial layers; he has never seen mitoses in the upper strata except in malignancy. Cullen agrees that mitoses in the cervical epithelium, squamous and columnar, occur only in the presence of cancer. He remarks that these nuclear fig-



Fig. 12. Section of cervix. High power view. Epidermalization into stroma, A, under normal columnar lining of glands, B. These new cells are basal in type. The whole picture is suggestive of a carcinoma stage.

ures are 'regularly met with in the epithelium of the body of the uterus and in cases of hyperplasia of the endometrium nuclear figures are frequently found in the stroma cells of the mucosa."

Martziouff doubts that mitotic figures are pathognomonic of cancer in the cervix and as previously mentioned he believes that even in the presence of marked cytological abnormalities there can be no definite diagnosis of cancer of the cervix unless the property of invasion is added (see Figs. 1 and 2).

In Figure 2 can be seen three mitotic figures lying closely together and surrounded by many abnormal cells. Cancer diagnosis of this section is nevertheless dismissed on account of the many normal cells in the field and the lack of general disorganization of the tissue.

#### DEDUCTIONS

A perusal of the above leaves one with a rather bewildered idea as regards the existence of a precancer state. There seems to be no doubt that the earliest cancers may present only an altered cytology and that tissues frequently labelled precancerous contain these cells which differ from cancer not so much qualitatively as quantitatively. It is also quite evident that many so called harmless precancers containing these abnormal cells are in reality definitely cancerous. It is a fact that there is a precancer state if we assume it to be the phase just short of cancer which has



Fig. 13. Low power view of gland overrun by an atypical type of squamous epithelium.



Fig. 14. High power view of blocked area, in Figure 13. Carcinoid change.

developed as a result of chronic irritation through the inflammatory and hyperplastic pathological stages. If we exclude from the term precancerous those abnormal states which may but never do develop into carcinoma there can be less objection to this much maligned and ill used word.

There is a much better terminology at hand such as (a) the word *carcinoid* of Borst which does not imply that the suspicious tissue must inexorably go on to cancer formation (b) the "approach cancer" of Itchikawa (c) *borderline* (d) *cancer like*, (e) "potentially cancerous" (f) *ill defined cancer*" and (g) "latent cancer. The best terms are *carcinoid* and "borderline and the word *carcinoid* probably meets the highest requirements and is the word that is most suitable.

The fact that not all of these *carcinoid* tissues go on to actual cancer does not detract from their importance in the prevention of cancer and a guarded attitude should be taken frequent local examinations with biopsies to ascertain any progress toward malignancy should be undertaken if necessary. This is probably the only way to distinguish those *carcinoid* conditions that will surely turn into malignancy later.

Clinically we know well that there is a precursory stage in cancer evolution as *precancer*. Are we then to exclude this stage completely and to speak of a tissue as either cancerous when it contains the altered cells previously described, or as non-cancerous otherwise? If we accept the theory of the presence of a *precancer* state how can we diagnose and orientate it how can we correlate the parallel findings of abnormal cytology in the two stages of *precancer* and cancer and how can we avoid labelling the *precancer* condition as really cancerous?

To the student of carcinoma of the cervix it seems rather premature and wrong to be forced to diagnose as *carcinomatous* those sections which present only a few altered cells of the malignant type in an otherwise normal field of cells arranged in an orderly fashion with no loss of polarity.

If we find interspersed between these suspicious cells many other cells which are only slightly altered and in fact quite normal, it can be reasonably certain that we are dealing with a stage just short of actual cancer (see Figs. 2 and 4 and compare with Figs. 15 and 16).

The fact that we find it impossible to lay down a perfect formula for the *precancer*

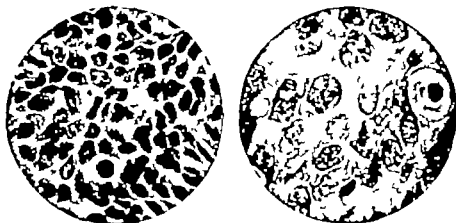


Fig. 15. Type of cells found in the carcinomatous layer. Note how in two separate cases of very early cancer of the cervix the carcinomatous layer shows atypical mitotic figures, atypical nuclei, and cells, and loss of polarity: in short a definite picture of cancer although there is no deep penetration as yet. The absence of normal type cells is very noticeable. (From Schiller Surg., Gynec. & Obst., 1933 Vol. 210 (X475))

stage does not preclude its existence. Study of the histogenesis of cancer would prove that there is such a precursory stage call it by whatever name is desirable.

Vital stains somewhat of the type described by Schiller (18) and Ludford would seem to be an ideal way at the moment to differentiate malignant from non malignant tissue.

As already described Schiller paints Lugol's iodine solution over the cervix and the cancer cells do not assume the stain remaining white, while the normal tissue becomes stained mahogany brown. Ludford's trypan blue when injected, causes normal cells to be stained in contrast to cancer cells which remain unstained. The contrast is best seen between normal fibroblasts and sarcoma cells, and normal and malignant mammary cells. Between normal and malignant skin cells, the difference is in degree rather than kind.

Further study is required to orientate those suspicious tissues labelled precancerous by observing if the field would take up differential stains and so provide the diagnosis.

It is interesting to mention that Schiller (18) noted a distinct demarcation between the carcinomatous layer and the normal epithelium. Areas of transition were nowhere to be found nor were there transitory cells. However he did see within the normal tissue near the borderline single dark cells which from a morphological standpoint are characteristic of

carcinoma. It seems logical to assume from the fact that this normal tissue was in close apposition to definitely established carcinoma, and already contained some cancer cells, that it was developing into actual incipient cancer, but at the time of examination was in a precursory stage of evolution (the carcinoid stage). The presence of a few single cancer cells was not sufficient however for Schiller to stamp the tissue as cancerous.

It is hard to reconcile the abrupt and sharp separation of cancer from the non-cancerous tissue if one believes that cancer is a gradual process.

#### CONCLUSIONS

A histopathological study has been made on sections of precancer of the cervix not so much to describe the condition as to demonstrate the points of relative similarity between it and the earliest cancers—this similarity causing a confusion in diagnosis and a lack of finality about the existence, orientation, or description of precancer. The following conclusions seem warranted.

1. Evidence goes to prove that in the cervix there does exist a precursory of cancer, the "precancerous" or "carcinoid" stage.

2. Cancer is definite diagnosed in the cervix only alone even when it downgrowth and the intact



Fig. 6 High power view from a frank case of squamous cell cancer of the cervix, patient aged 35 years. The cells show marked polymorphism and hyperchromatism, with intact basement membrane. The loss of polarity is well shown.

3 Many of the carcinoid conditions which are found in the cervix uteri as a result of chronic irritations show an altered cytology which is comparable to that found in the genuine cancers; consequently there is much confusion as to the proper diagnosis.

4 Although there are not to be had unassailable scientific histological criteria for carcinoid conditions, there still is a satisfactory means of diagnosis of the condition in the cervix viz: (a) the general appearance is not suggestive of established cancer; (b) very few actual cancer like cells are present, and these are single and detached; (c) these altered cells are surrounded and separated by too many normal cells usually very similar in type; (d) there is very little or no loss of polarity.

5 An attitude in general that cancer may be mimicked perfectly histologically and still cancer not be present is a mistaken and dangerous one. There is no doubt that many such cases are really cancerous.

6 Vital stains (Schiller-Ludford) offer a suitable method of diagnosing the earliest actual cancers and of differentiating them from carcinoid conditions.

7 For the final histological diagnosis of suspicious tissue in addition to vital staining there is required biopsy examination with the microscope. The biopsy should be cut transversely, be sectioned serially for microscopic study, and there must be repeated removal of tissue for examination if necessary.

#### BIBLIOGRAPHY

- ADAMI and McCRAE. Text Book of Pathology, 2d ed. Philadelphia: Lea & Febiger, 1914.
- 1 BRODERS, A. C. J. Am. M. Assn., 1932, xcix, 1670.
- 2 CALLEN, T. S. Johns Hopkins Hosp. Bull., 1922, xcix, 32.
- 3 EWING, Neoplastic Diseases, 2d ed. Philadelphia: W. B. Saunders Co., 1922.
- 4 FRANK, R. T. Gynecological and Obstetrical Pathology. New York: D. Appleton & Co., 1921.
- 5 HUGHES, R. R. Am. J. Obst. & Gynec., 1922, lv, 552.
- 6 KELLER, R. and VAN DE VIVER, L. Gynec. et Obst., 1920, ix, 605.
- 7 LUDFORD. Quoted by Frank, R. T. Loc. cit.
- 8 LUDFORD, R. J. Proc. Roy. Soc. Lond., 1920, civ, ser B, 493.
- 9 MARTELOW, K. H. Am. J. Obst. & Gynec., 1924, xxi, 57.
- 10 MEYER, ROBERT. Ztschr. f. Geburtsh. Gynäcol., 1927, No. 9, 464-480.
- 11 MEYER and LAUCACCI-KITATI. Zentralbl. f. allg. Path. u. anat. Path., 1926, No. 35, pp. 336-342.
- 12 NOVA, EMIL. Gynec. T., 1920, li, 306.
- 13 ORTTEL, H. Canadian M. Assn. J., 1926, xvi, 237.
- 14 RUBIN, Am. J. Obst., 1910, lvi, 668.
- 15 SCHACKENBEEK, Arch. f. Gynäcol., 1908, lxxxv, 576.
- 16 SCHILLER, W. Arch. f. path. anat., 1927, cxxvii, 279.
- 17 SCHILLER, W. Surg. Gynec. & Obst., 1923, lvi, 510.
- 18 SCHOTTLANDER. Gynäcol. Rundschau, 1922, p. 500.
- 19 STONE, W. S. Surg. Gynec. & Obst., 1924, xciv, 245.
- 20 VILLARD, E. and MORRELL, G. Gynec. et Obst., 1920, vi, 9.

I THE X-RAY MEASUREMENT OF THE FETAL HEAD DIAMETER  
*IN UTERO*<sup>1</sup>

AN ACCURATE TECHNIQUE BY MEANS OF STEREOROENTGENOMETRY

STEWART H. CLIFFORD M.D. BOSTON

A NUMBER of methods of cephalometry *in utero* have been studied in this clinic during the past 2 years and the accuracy of each tested by comparison with the actual head measurements obtained after birth. The method finally evolved and here recommended is an adaptation of the stereo roentgenometric technique originally used by MacKenzie-Davidson and recently independently developed and described by Clayton R. Johnson. The advantage of the refinement of the technique herein described lies in that through tests applied to the finished film and through added controls it is possible to recognize prior to the birth of the infant those deformations which can be relied upon with a high degree of accuracy.

## HISTORICAL

The earliest attempts to measure the fetal head *in utero* were by direct caliper measurements through the abdominal wall. This method was used with considerable success by Budin and Perret in 1899. Stone in 1905, McDonald in 1906 and Reed in 1917. McDonald was able to measure 41 heads with 100 per cent accuracy to within 0.5 centimeter and with 76 per cent accuracy to within 0.3 centimeter. Reed could obtain a measurement in only 85 out of 100 attempts to measure the head through the abdominal wall because of the presence of hard abdominal walls or excessive fluid or because of the small size of a premature infant's skull. He found his results were correct to within 0.5 centimeter in 93.5 per cent of the cases he could measure and to within 0.25 centimeter in 67.7 per cent. This method of cephalometry has not become popular in spite of its good showing probably because a high degree of personal skill must be acquired before the results obtained can equal those of the authors quoted and because it is in those cases in which the information is most desired that the measure-

ments are apt to be unreliable if not impossible to obtain.

Hirsch has given a concise review of the various attempts to utilize the X-ray for pelvimetry. He points out that 5 general methods were developed many years ago and all modern methods are in fact minor adaptations of these fundamental techniques.

1 *Comparative methods* in which the exposure of the pelvis in the living is compared with a normal specimen taken under identical conditions.

2 *Teleroentgenographic methods* in which the X-ray target is placed far enough from the object to obtain parallel rays and eliminate distortion.

3 *Frame methods*, first suggested by Fabre and Fouchet in 1899 in which a metal frame with its borders notched at centimeter intervals is placed around the patient's pelvis in the plane of the diameter to be measured. The popular Thoms technique is based upon this method except that after the first X-ray the patient is removed from the table and a lead plate perforated at centimeter intervals is placed in the plane to be measured and a second flash exposure made.

4 *Triangulation methods* in which two exposures are made on the same film or on two separate films that are later superimposed. In taking the X-rays the shift of the target is a known distance and the target film distance is also known. "The two shadows of the point in the body are connected and the location of the point above the plate surface may be estimated by a mathematical formula or by a phantom with strings utilizing the target plate distance, the target displacement and the shadow displacement distance as known factors." (5) This is the principle of the technique first used by Levy and Thumin and by MacKenzie-Davidson in 1898. The methods of Chamberlain and Newell (1921) and Johnson (1927) are recent examples.

<sup>1</sup>Studies on the Reduction of the Newborn Infant Death Rate from the Boston Lying-in Hospital, the Departments of Obstetrics and Pediatrics of the Harvard Medical School, and the Department of Child Hygiene of the Harvard School of Public Health. Part of communication originally read before the Boston Obstetrical Society on October 3, 1931.



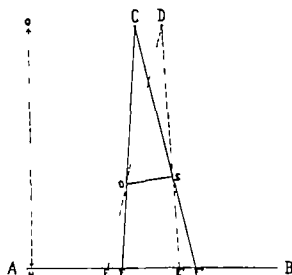


Fig. 1. Diagram illustrating the theory of stereoroentgenometry. For explanation see the text.

5 *Stereoscopic methods* in which stereoscopic exposures are made and viewed in the regular way. By the use of an illuminated ruler or movable metallic points, placed directly in the phantom image, the pelvis may be accurately measured. It is thus apparent that most of the methods reported in the last few years have been but modifications of the original principles laid down by Varnier, Albert Fabre, and MacKenzie Davidson. (5)

#### SEARCH FOR A SATISFACTORY METHOD OF CEPHALOMETRY

Direct measurements through the abdominal wall were not attempted for the reasons already enumerated. The method of teleroentgenometry was not applicable because of the long exposure required during which movement of the fetal head probably would occur. Thoms' modification of the frame method was used in 30 consecutive determinations with 57 per cent accuracy to within 0.3 centimeter and 67 per cent to within 0.5 centimeter. The mistaken predictions were found to be as much as 3.5 centimeters in error in some instances when compared with the actual head measurement. Walton's variation of Thoms' technique was given a brief trial but was found to possess no advantage over the former method. The frame method of cephalometry

requires an experienced person to locate accurately the plane of the occiput and sinciput in space. In which plane the perforated lead plate must be placed for the subsequent flash exposure. This trained individual must obviously be present in person no matter at what hour the request for an X-ray is received. The chief objection to this method, however, was that in the individual case, prior to the birth of the baby it was impossible to foretell whether the measurements obtained would represent one of the accurate readings or be one of the 33 per cent erroneous determinations. On the basis of our experience we could not recommend this method as sufficiently accurate and reliable for practical use.

In order to do the Thoms method justice the literature was reviewed to ascertain its success in other hands. Thoms, Walton, and Jarcho, although primarily interested in pelvimetry, have described this procedure as a means of fetal cephalometry. It was impossible to find in any of their published reports a single case in which the accuracy of a predicted fetal head size was verified by actual measurements obtained after birth.

The triangulation method as independently worked out by Johnson and called by him 'stereoroentgenometry' was next tried. Using Johnson's technique, we were able to predict the head size correctly in a fair percentage of the cases only then to encounter a series of erroneous determinations. It was impossible to ascertain from Johnson's writings what degree of success he had achieved, for although he described and recommended his technique as a means of cephalometry, no evidence was submitted in which the accuracy of his predictions was verified.

Hirsch has stated that while the stereoscopic method is used by Druner, Pulfrich, Trendelenburg, and others on the continent, it is little used in this country. We have had no personal experience with this method.

*Stereoroentgenometry.* The theory of the method is better understood by reference to Figure 1, in which AB is the position of the X-ray film. C is the position of the target at one end of its shift from which the first exposure is made. D is the target position for

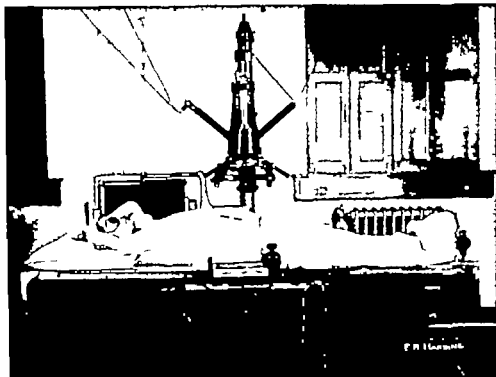


Fig. 2. Patient in position upon radioscopic table prior to obtaining stereoroentgenograms.

the second exposure 7 centimeters ( $2\frac{3}{4}$  inches) from  $C$ .  $GH$  is the distance from the plane of the target to the film or 63.5 centimeters (25 inches).  $OS$  is the position in space of the object to be measured.  $E$  is the projection of point  $O$  on to the film when exposed from target position  $D$ .  $F$  is the displaced position of  $O$ 's shadow when the film is exposed from target position  $C$ .  $E'$  is the projection of point  $S$  on to the film when the target is at  $D$ .  $F'$  is the projection of point  $S$  when the target has been horizontally shifted to  $C$ .

Through the construction of a dummy with strings (Fig. 9) in which the original conditions under which the pictures were taken are duplicated it is possible to start at the displaced shadows  $E$  and  $F$  of the common point  $O$  in space and retrace the path taken by the light rays back to their source at targets  $C$  and  $D$ . In such a reconstruction the point of crossing of the strings locates the position in space that must have been occupied by point  $O$  (Fig. 10). The position of point  $S$  in space can be similarly located and the distance between  $O$  and  $S$  directly measured (Fig. 11).

*Roenigenological equipment necessary.* Any standard radioscopic table (Fig. 2), equipped with a Potter Bucky diaphragm and capable of taking stereoscopic pictures a horizontal shift being used can be readily adapted for the technique. The shift of the X ray tube that we use is 7 centimeters ( $2\frac{3}{4}$  inches), 3.5 centimeters ( $1\frac{3}{8}$  inches) to either side of the center.

The films when taken must be so marked that when the time comes for mensuration they can be placed in the stereoroentgenometer preserving the same relationship to the dummy targets that they did to the original ones. The longitudinal plane of the targets can be identified if 3 or 4 lead shot are embedded, about 6 inches apart into the midline of the table surface so that their images will be cast upon the exposed film (Fig. 3). These markers must be planted at mid points in the cross diameter of the table so that if a plumb line were to be dropped from the target center at either end of its longitudinal shift it would fall on a line connecting these markers.

The lateral plane of the target is located in the exposed film by the shadow of a wire that is stretched across the middle of the cassette

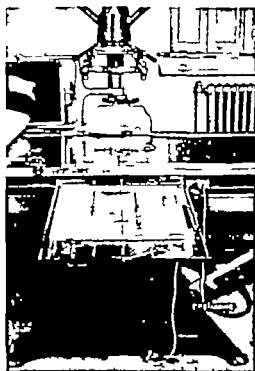


Fig. 3. Photograph illustrating the conversion of standard radioscopic table to one capable of taking stereoröntgenograms. Lead shot has been buried in the surface of the table in the centers of the paper rings. A length of flexible wire has been fastened in the center of the inner side of the tray drawn across the surface of the cassette and through a notch cut in the center of the outer edge of the tray where it is clamped in position.

(Fig. 3) The inner end of this wire is permanently fastened through a hole drilled in the middle of the inner edge of the Bucky diaphragm tray. It is then drawn tightly across the top of the cassette and through a notch that is cut in the center of the outer edge of the tray and here clamped in position. In the finished plate this wire crosses the line of the lead markers at right angles and their intersection identifies the point perpendicularly below the center of the X ray target when it is at its normal resting position in the mid point of the stereoshift.

The technique is checked for technical errors by securing two 10 centimeter metal rods at different points upon the patient's abdomen so that their shadows will appear in the finished plate (Fig. 2).

*Measurement equipment necessary.* The finished X ray films are measured through an

instrument called by Johnson a "stereoröntgenometer." Figures 9, 10, 11 demonstrate that it is not as formidable as its name would imply. The apparatus pictured is a homely copy of that used by Johnson but has the advantage of being inexpensive and simple to make while at the same time it gives very accurate readings. The base of the frame serves to hold the X ray plates in position on the viewing cabinet. The under surface of the projecting arm is 63.5 centimeters (25 inches) from the surface of the films. Three small holes are drilled through this arm: the middle one represents the target at its normal position in the center of the shift and through this hole a plumb-bob is suspended to locate the intersection of the cross wire and the lead marker lines. The two other holes are placed 3.5 centimeters (1.38 inches) to either side of the middle hole in the line of the longitudinal tube shift. Through each of these a round elastic cord is passed and attached one to each arm of a compass. Adjustable metal pointers are provided to record the position in space of the objects located.

The X rays are viewed through a horizontal illuminated cabinet. A centimeter rule and a Bertillon cephalometer capable of measuring 0.1 centimeter complete the list of equipment.

*Röntgenographic technique.* The patient is placed upon the table in a horizontal position (Fig. 2). The tube is centered over the approximate location of the fetal head. The Potter-Bucky diaphragm with its tray containing the unexposed film is released from its attachment to the X ray tube carriage leaving the tube free for its longitudinal shift of 3.5 centimeters to either side of this central point. The brakes of the Bucky diaphragm are locked firmly anchoring it to the table to guard against accidental dislocation of the X ray plate during the examination. The flexible picture wire is drawn tightly across the top of the cassette through the notch and clamped in position (Fig. 3). One of the 10 centimeter rods is fastened with adhesive tape over the patient's symphysis and the other is located at some convenient point on the abdomen. The patient's abdomen is firmly compressed by a bladder attached to the table.



Fig. 4. Skullgrams with the fetal heads outlined, demonstrating satisfactory lateral views of the skull from which occipitofrontal diameters can be obtained.

The tube is placed at one end of the stereo-shift and the first exposure is taken. We are using a Westinghouse radiographic heavy duty tube with a  $4\frac{1}{4}$  to 5 inch spark gap 50 milliamperes and an exposure of from 6 to 12 seconds.

A fresh cassette is placed in the tray the wire redrawn across its surface the Potter Bucky diaphragm reset the target displaced to its second position and the final exposure is made.

*A review of important points in the technique influencing its accuracy* 1. The target when at the center of its longitudinal shift must be in a plumb line with the intersection of the line of the lead markers and the cross wire over the cassette.

2. The longitudinal shift of the \ ray target must be not more or less than 7 centimeters. The force of inertia may carry the \ ray tube beyond the shift stop unless the apparatus is rigidly locked.

3. The target film distance must always be 63.5 centimeters (25 inches).

4. The Potter Bucky diaphragm carriage must be locked in its tracks so that the position of the \ ray plates will not alter their relationship to the rest of the apparatus. Unless this precaution is taken the carriage may be moved in the haste of introducing the second \ ray film and resetting the diaphragm. Such a shift upsets all calculations and results in a false reading.

5. The patient must not move between the two exposures.

6. The hazard beyond our control is movement of the fetal head between the two exposures. The vast majority of unsuccessful examinations are due to this cause. The shorter the interval permitted to elapse between the two exposures the less will be the chance of motion spoiling the determination. An important feature of the technique here recommended is that a means is provided whereby evidence of fetal head movement may be detected in the finished film and an erroneous reading thus avoided.

*Interpretation of the roentgenograms* 1. Is there a measurable diameter of the fetal head present? Fortunately for the success of this method actual experience has demonstrated that in the great majority of \ rays the shadow of the greatest or occipitofrontal diameter of the head is cast upon the film. Thoms has shown that in the lateral view of the head the fetal skull may be rotated 36 degrees in either direction before the shadow of the occipitofrontal diameter is shortened a millimeter. Very little experience is required before a satisfactory lateral view of the head can be recognized on the finished plate (Fig. 4). The points to look for are a long oval silhouette in which the occiput and sinciput, the anterior and posterior fontanelles and the maxilla and mandible may be identified.

The anteroposterior shadow of the skull, from which the biparietal diameter may be ascertained is encountered in about 7 per cent of the cases. A true anteroposterior silhouette (Fig. 5A) can be identified from the

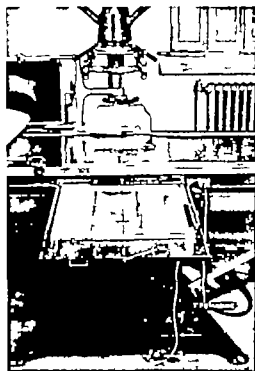


Fig. 3. Photograph illustrating the conversion of a standard radioscopic table into one capable of taking stereoradiographs. Lead sheet has been buried in the surface of the table in the centers of the paper rings. A length of flexible wire has been fastened in the center of the inner side of the tray drawn across the surface of the cassette and through notch cut in the center of the outer edge of the tray where it is clamped in position.

(Fig. 3). The inner end of this wire is permanently fastened through a hole drilled in the middle of the inner edge of the Bucky diaphragm tray. It is then drawn tightly across the top of the cassette and through a notch that is cut in the center of the outer edge of the tray and here clamped in position. In the finished plate this wire crosses the line of the lead markers at right angles and their intersection identifies the point perpendicularly below the center of the X-ray target when it is at its normal resting position in the mid point of the stereoshift.

The technique is checked for technical errors by securing two 10 centimeter metal rods at different points upon the patient's abdomen so that their shadows will appear in the finished plate (Fig. 2).

*Measurement equipment necessary.* The finished X-ray films are measured through an

instrument called by Johnson a stereoradiometer. Figures 9 10 11 demonstrate that it is not as formidable as its name would imply. The apparatus pictured is a homely copy of that used by Johnson but has the advantage of being inexpensive and simple to make while at the same time it gives very accurate readings. The base of the frame serves to hold the X-ray plates in position on the viewing cabinet. The under surface of the projecting arm is 63.5 centimeters (25 inches) from the surface of the films. Three small holes are drilled through this arm the middle one represents the target at its normal position in the center of the shift and through this hole a plumb-bob is suspended to locate the intersection of the cross wire and the lead marker lines. The two other holes are placed 3.5 centimeters (1 3/8 inches) to either side of the middle hole in the line of the longitudinal tube shift. Through each of these a round elastic cord is passed and attached one to each arm of a compass. Adjustable metal pointers are provided to record the position in space of the objects located.

The X-rays are viewed through a horizontal illuminated cabinet. A centimeter rule and a Bertillon cephalometer capable of measuring 0.1 centimeter complete the list of equipment.

*Radiographic technique.* The patient is placed upon the table in a horizontal position (Fig. 2). The tube is centered over the approximate location of the fetal head. The Potter Bucky diaphragm with its tray containing the unexposed film is released from its attachment to the X-ray tube carriage leaving the tube free for its longitudinal shift of 3.5 centimeters to either side of this central point. The brakes of the Bucky diaphragm are locked firmly anchoring it to the table to guard against accidental dislocation of the X-ray plate during the examination. The flexible picture wire is drawn tightly across the top of the cassette through the notch and clamped in position (Fig. 3). One of the 10 centimeter rods is fastened with adhesive tape over the patient's symphysis and the other is located at some convenient point on the abdomen. The patient's abdomen is firmly compressed by a binder attached to the table.

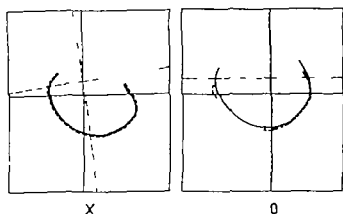


Fig. 7. X. Tracing from a case in which flexion or extension of the fetal head occurred between the two exposures. With the head silhouettes coinciding the longitudinal lines are found to have crossed each other. O. Tracing from a case in which rotation of the fetal skull occurred. The head shadows cannot be made to coincide, one being shorter and rounder while the other is more oval and longer.

measured. If the occipitofrontal diameter is to be obtained the greatest possible diameter of the skull is used.

3. Superimpose both head silhouettes with the longitudinal lines either coinciding or parallel. Locate identical points on the second skull by perforating through the holes already made.

*Actual technique of mensuration.* 1. Superimpose the longitudinal lines and the shadows of the lateral cross wires and place the films in this position upon the viewing cabinet (Fig. 8).

2. Place the stereorontgenometer squarely upon the films and drop the plumb bob adjusting the films so that it falls at the intersection of the cross lines (Fig. 9).

3. Cross the elastic strings once and place the compass ends on the displaced identical points of one end of the skull diameter to be first located. Fix one pointer at the point of intersection of the strings (Fig. 10). In a similar manner measure the displaced identical points of the other end of the skull diameter and adjust the second pointer to the point of intersection of the strings.

4. Actually measure the distance between the two pointers (Fig. 11).

5. Following the same routine check the accuracy of the technique by measuring the displaced shadows of the 10 centimeter rods. The error should not exceed 0.2 centimeter.

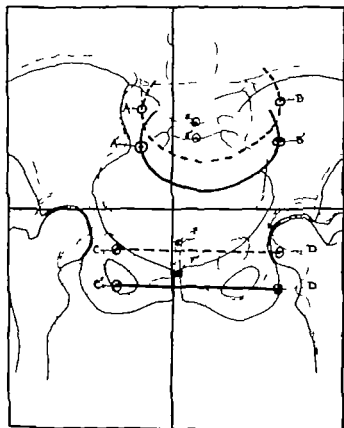


Fig. 8. Tracing from superimposed stereorontgenograms in position for mensuration with the longitudinal and lateral lines coinciding.

#### STATEMENT OF RESULTS

1. The technique described subdivides the X-ray films into 3 classes depending on whether or not movement of the fetal head has taken place between the 2 exposures. Class A films in which there has been no motion, Class B films in which there has been slight motion in the lateral plane. Class O films in which there has been so much motion that any attempt at mensuration will give unreliable results.

2. By means of the stereorontgenometric technique 167 consecutive X-ray determinations of the size of the fetal head *in utero* were made and checked by actual measurement of the head at birth.

Ninety-one of the plates were rated Class A and were 97 per cent correct to within 0.3 centimeter while 99 per cent were correct to within 0.5 centimeter.

Of the plates 26 were rated Class B and were 80 per cent correct to within 0.3 centimeter and 100 per cent correct to within 0.5 centimeter.

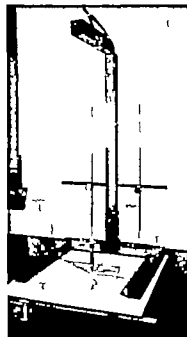


Fig. 9.

Fig. 9 Stereoradiometer located for mensuration by means of a plumb-bob dropped to the intersection of the cross lines

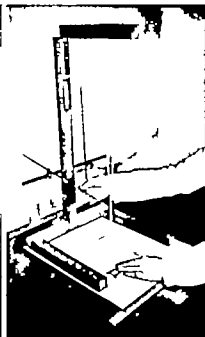


Fig. 10.

Fig. 10 Locating in space the end point of one of the diameters of the fetal head to be measured

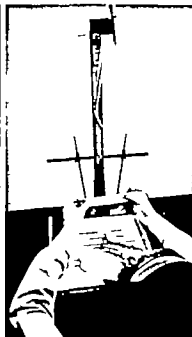


Fig. 11.

Fig. 11 Actual measurement between the two discovered end points of the fetal head diameter

Fifty determinations were in the inaccurate and unmeasurable Class O

3 In 70 per cent of the total of 167 stereoradiograms a satisfactory X ray of Classes A or B was obtained and an accurate prediction given at the first X ray examination

In 78 per cent of the 124 vertex presentations found in this group it was possible to obtain a satisfactory X ray and give an accurate prediction at the first examination

In 49 per cent of the 43 breech presentations found in this series it was possible to obtain a satisfactory X ray and give an accurate prediction at the first examination

4 In 147 X ray examinations 117 in this series and 30 using the lead grid a satisfactory occipitofrontal diameter was found presenting in 93 per cent of the cases. A measurable biparietal diameter usually was obtained in the remainder. The oblique diameter was infrequently encountered

5 The principal cause of the 50 unsuccessful X ray examinations was movement of the fetal head between the 2 exposures.

#### EVALUATION

Stereoradiometry would qualify as a most satisfactory method of cephalometry if movement of the fetal head *in stereo* could be eliminated. This factor cannot be controlled, but the method describes a means of recognizing this movement when it has occurred and thus avoids an unreliable prediction

Very little movement of the fetal head is encountered in vertex presentations because of the wedging of the head in the neck of the uterus. The results of stereoradiometry are entirely satisfactory in this group with 80 per cent of all attempted examinations resulting in accurate predictions. When movement does occur and thus produces an unmeasurable film the chances are that a second examination will result in an accurate measurement

It has been in the breech presentations that the results have been the least satisfactory for here with the head free to move in the fundus of the uterus considerable movement is encountered. An attempt to obtain a measur-

able film of the head in this group carries with it a 50 per cent chance for success at the first examination. The law of probability greatly increases the chances for success with each succeeding examination.

Fully appreciating the shortcomings of this method of cephalometry the fact remains that a measurable X ray in which there has been little or no movement of the fetal head can be obtained in a high percentage of the cases examined, and when such a film has been identified an accurate prediction as to the actual size of the skull can be given in practically every case.

The question may well be asked as to why X ray pelvimetry has not been mentioned in connection with the studies on X ray cephalometry. As a matter of fact, we have attempted to measure the true conjugate diameter of the pelvis in all of the cases examined but as yet we are not convinced of the accuracy of any of the methods advocated. It was an easy matter to check the accuracy of any method of cephalometry by actual measurements of the head after birth. It was extremely difficult to know whether the figure obtained for the true conjugate by X ray actually represented the true diameter. The verification of the X ray prediction in this case can be accomplished only through actually measuring the true conjugate during an abdominal exploration or at postmortem examination. The estimated conjugate vera that we obtained by X ray examination and from the clinical determination of the diagonal and external conjugate did not conform with any degree of accuracy. Thoms Chamberlain and Newell, Roberts Walton, Jarcho, Heublein et al. and Moore have all written on X ray pelvimetry but none have submitted data to confirm the accuracy of their determinations. Johnson offered the external conjugate diameter to compare with his estimated true conjugate, but the average discrepancy between the estimated true conjugate from the 2 sources was 2.5 centimeters.

It seems reasonable that before any method of pelvimetry can be accepted as an adjunct to obstetrical practice on the results of which the patient's welfare may depend it must first be required to pass a rigid test for ac-

curacy *A priori*, a method such as Johnson's that has proved its ability to measure the fetal head, should be capable of measuring the pelvic diameters. There is certainly no problem of motion in pelvimetry such as there is in fetometry but to replace it there is the real difficulty as to where on the flat plate the end points of the true conjugate shall be placed. At present we are comparing a series of actual true conjugate determinations, obtained incidentally during abdominal operations, with the estimated true conjugate obtained later by the stereoroentgenometric technique. Until the reliability of any method of pelvimetry is thus established it cannot be accepted as of practical value.

#### CONCLUSIONS

A technique of stereoroentgenometry has been described by which it is possible to predict the size of the fetal head *in utero* to within 0.3 centimeter in 97 per cent of the cases in which an occipitofrontal or biparietal diameter is present and movement of the head between the stereoroentgenograms has not occurred.

Means are described whereby the X ray picture of a measurable head diameter can be identified and motion of the fetal head between the 2 exposures can be detected when it occurs.

Eighty per cent of the vertex presentations and 50 per cent of the breech presentations were accurately measured at the first examination. Movement of the fetal head between the 2 necessary X ray exposures was found to account for practically all of the unsatisfactory examinations.

I wish to express my appreciation for the interest and co-operation of Dr. Frederic C. Irving, Dr. Samuel A. Robins, and the members of the house staff of the Boston Lying in Hospital. I am especially indebted to Dr. Thomas R. Goethals for his valuable assistance throughout the course of this study and to Miss Helen Wilkins, R.N. for her skillful roentgenography.

#### BIBLIOGRAPHY

1. BUDIN and FERRIET. Actual measurement through the abdominal wall. *Obstet.*, November 1899. (Quoted from McDonald.)
2. CHAMBERLAIN, W. E., and NEWELL, R. R. Pelvimetry by means of the roentgen ray. *J. Roentgenol.*, 1921, viii, 372.
3. FABRE and FOUCHET. Quoted by Hirsch loc. cit.



4. HUGHLEIGH A. C., ROBERTS, D. J., OGDEN, R. T. Roentgen pelvimetry after Thomas. *Am J Roentgenol.*, 1928, xv, 64.
5. HIRSCH, I. SETH. Discussion of paper by Thomas, outlining the superior strait of the pelvis by means of the X-ray. *Am J Obst. & Gynec.* 92. iv 36-370.
6. JARVIS, J. Roentgenographic measurement of pelvis and cephalic diameters. *Am J Surg.* 931 xv 49-437.
- JONES, CLAYTON R. Stereoroentgenometry—a method for mensuration by means of the roentgen ray. *Am J Surg.* 1930, *et al.*, 5-163.
8. LEVY and THURMOND. Quoted from Hirsch, loc. cit.
9. MACKENNIE DAVIDSON, SIR J. Localization by X-rays and Stereoscopy. New York: Paul B. Hoeber 1916.
10. McDONALD, ELLICE. Mensuration of the child in the uterus with new methods. *J Am M. Ass.*, 906, xlvii, 19-9-1953.
- MOORE, GEORGE E. A simplified type of roentgen pelvimeter. *Am J Surg.* 932 xvi, 2 6-20.
12. REED CHARLES B. A study of fetal maturity *in utero*. *Surg. Gynec. & Obst.*, 1917 xiv, 201.
3. ROBERTS, R. E. Internal pelvimetry by X-rays. *Brit J Radiol.* 1927 xxxii, 11 15.
4. STOUT. *Med. Rec.*, 1905, Nov 4. Quoted from McDonald.
5. THOMAS, HERBERT. Outlining the superior strait of the pelvis by means of the X-ray. *Am J Obst. & Gynec.*, 1922, iv 257-263.
- Idem. Pelvimetry of the superior strait by means of the roentgen ray. *J Am M. Ass.*, 925, lxxxv 253.
- Idem. A new method of pelvimetry. *J Am M. Ass.*, 1929, xcii, 15 5-1516.
- Idem. The determination of fetal maturity *in utero*. *Am J Obst. & Gynec.*, 1930, xx, 807.
- Idem. Fetal cephalometry *in utero*. *J Am M. Ass.*, 930, xxv, 21-24.
6. WALTON, H. J. Roentgenological pelvimetry and intra-uterine cephalometry. *Surg. Gynec. & Obst.* 931 lli, 516-558.

# CLINICAL SURGERY

## A SAFE AND SATISFACTORY METHOD OF ANÆSTHESIA FOR TOXIC GOITER PATIENTS

WILLARD BARTLETT M.D. F.A.C.S. AND WILLARD BARTLETT JR. M.D., ST. LOUIS, MISSOURI

CONSIDERATIONS of a physiological nature should obtain in influencing us to choose an anæsthesia method which comports with the peculiar needs of the hyperthyroid patient. The observer who has seen a restless patient of this class become perfectly quiet immediately after being placed in the oxygen tent requires no further argument to convince him that "local" possesses an undoubted advantage over any oxygen displacing inhalation anæsthesia. This is the definite reason why local anæsthesia should be employed on the toxic thyroid patient, it being illogical to interfere with the oxygen supply (it will be generally admitted that every form of inhalation anæsthesia disturbs the cellular respiration—Crile—and is hence to some extent dangerous) by inhalation anæsthesia of a patient whose oxygen need is increased in proportion to the severity of her malady especially if an adequate technique will prevent the patient from recognizing or remembering the operative procedure. This is obviously essential if the highly nervous individual is to be afforded the advantages of local anæsthesia.

It happens too now and then that a thyrotoxic storm follows operation where least expected. Certain patients are always *potentially* toxic if not actually so when examined. These are no doubt in great part individuals whom we see in a more or less complete remission though we are or seem to be, unable to establish the fact that they have ever been hyperthyroid. A further reason for employing some form of local is that the type of anæsthetic regulates in many instances the amount of bleeding caused by a thyroidectomy hence regulates automatically the period required for hemostasis, therefore determines to no small extent the length of the operation. Inhalation anæsthesia tends to increase the blood pressure something especially noticeable in a patient who struggles at all particularly is it true when cyanosis makes its appearance as gas supplants oxygen, or when mucous floods the air passages, or when the trachea is maltreated as

happens more often to the fully unconscious patient whose pressure symptoms disturb the operator as well as herself.

A minor advantage for the use of 'local' lies in the fact that no atropine is needed to prevent or limit the excessive secretion of the mucus which complicates the employment of inhalation anæsthesia. This outpouring has gone so far as to cause interruption of the operation in our hands it also has persisted as the most disagreeable feature of the few early postoperative days. Atropine tends further to rouse the sleepy patient if employed along with basal anæsthesia, hence its use is not to be recommended if it can be avoided (Gruber) still we are forced to employ it, though very rarely, when an excessive amount of mucus is secreted no matter what the circumstances.

We never operate on a toxic goiter patient until a relatively satisfactory state of remission has been reached, consequently a certain degree of inhalation anæsthesia may be tolerated so far as the patient's sensitivity to oxygen deficiency is concerned although one who goes through operation under local anæsthesia alone is certainly somewhat better off and the surgeon is definitely in a better position if there be no respiratory overactivity and no increased consequential bleeding. On the other hand, one must admit that no such patient is wholly comfortable on the table confinement of legs and arms as well as the position of the head leave much to be desired there is often a sense of suffocation from pressure on the trachea there is surely some retraction of muscles and traction on thyroid tissue which contribute to the discomfort there is, too a general sense of danger while in the operating room. Many sensitive patients, even though drugged, are unsuited to this combination of circumstances hence a little gas (we prefer ethylene) should always be given or even urged on the patient when any need of any sort arises. A perfect thyroidectomy is the object aimed at the anæsthesia must always be regarded as of secondary importance.



Fig. 1. The heavy circle marks indicate the injection points for blocking the nerve supply to every structure in front of the thyroid gland. As a matter of course two injections are required on each side of the neck.

"Local" is a failure if the patient realizes the nature of her anesthesia (when toxic). It must be covered" by "dope" before entering operating room or by gas in the operating room. We prefer the former because blood pressure is usually lowered the operating room is practically never recognized there is no cyanosis, increased bleeding, difficulty with vomiting or difficulty in managing the patient. Neck muscles are relaxed, hence access to the tumor is simplified while it gives postoperative sedation as well. The pre-operative drugging of patients on whom local anesthesia is to be employed is a matter worthy of more detailed study. Certain types, for example, of toxic goiter patients are totally unsuited to the use of local anesthesia without preliminary drugging or gas inhalation on the table. One may go to the other extreme and so heavily drug an individual that an operation may be done without any type of local or other anesthesia. In this event, of course, injections are not felt but the margin of safety is rendered so narrow that this extreme is always as objectionable as the one first mentioned. There is, however, a middle ground where a certain moderate degree of drugging renders the patient oblivious to her surroundings but still leaves her the power of co-operation even though she is conscious of what is

going on. This co-operation is indispensable else she is unmanageable on one hand or too close to the dead line on the other. Phenobarbital sodium, grains 15 in broken doses,<sup>1</sup> has served us better than any other drug we have used for this purpose though on occasion we have had to supplement it with a small dose of morphine before the ideal condition has been realized.

Toxic goiter patients were once operated upon, or at least anesthetized, in bed in our service, but the procedure of managing them has been much simplified by the semi-anesthesia thus induced. They are now taken to the operating room with no special precautions while under its influence such a patient has no anticipation, no experience, and no recollection of the operating room, hence we no longer find any advantage in doing thyroid operations in the patient's bed with the undesirable features attendant on same. An especial consideration is to be accorded the patient who must be deceived as to the second stage of a hemithyroidectomy: she is told that a laboratory examination is indicated, is given the basal anesthesia in mildly augmented dose, then when she wakes she is back in bed, having been to the operating room without her knowledge.

No general rule for anesthesia is applicable to 100 per cent of the patients as will be shown by a perusal of two case history abstracts which follow. The patient's nervous make-up due to inheritance, environment, or disease is primarily responsible for the degree of anesthesia we are able to secure by whatever method. Mrs. B., July 16, 1931 had been given phanodone, grains 15, morphine, grain  $\frac{1}{4}$  superficial nerve block, a little gas, still any manipulation of her neck caused struggling. We cut "flaps" and put back to bed this toxic goiter patient who was more unstable than we had supposed. (Needle pricks during skin closure awakened no response, proving that she had a fair analgesia.) This should not happen today in view of our improved ability to judge the patient's pre-operative condition. A different situation was manifest with Mrs. M., September 1931 who without any pre-operative anesthetic drug was calm and co-operative for ligation, everything being understood though every barbiturate had made her maniacal, so uncontrollable in fact that return to bed was necessitated on a previous occasion. Morphine had caused excessive nausea and vomiting at a second trial. Full ethylene was satisfactory after she refused "local" on a third attempt. All general rules were abandoned finally, but the patient was satisfactorily treated by individualization. (We

were still doing a few ligitations 2 years ago while still developing the anæsthesia method which is now our standard)

Individualization is the key to success in the use of local anæsthesia. In many instances the mask is never on the face after the skin incision; some patients seem to get much soothing effect from its mere presence while a very few really require an infinitesimal amount of gas at some period of the operation, luxation of a lobe for example. The surgeon should keep in mind the fact that the degree of anæsthesia is dependent first of all upon the personality of the patient, one who is by nature unruly and by circumstance undisciplined cannot be completely controlled by any drug having a general action short of the danger line. On the other hand, the margin of safety is increased according to the co-operative spirit manifested by the individual. Dr. Sidney I. Schwab long ago called my attention to this fact which has been most helpful in my operative work and should be in the background of every anæsthesia no matter what its nature—this general principle should incidentally, be well known to every patient about to enter the anæsthetic state.

A trained and sympathetic anæsthetist is indispensable for 'local' work upon the toxic goiter patient. The mask is off her face most of the time, as remarked, though she is stabilized at all times by the right sort of a voice at her ear. Any minor complaint whatsoever must be met in this manner, while dilute carbon dioxide and oxygen seem to combat any tendency to nausea or vomiting.

Some compromise between general" and "local" seems to produce the most nearly ideal anæsthesia for the average thyroid patient, true for the surgeon, at least, who considers the thyroidectomy of primary importance even though he may lean strongly toward the anæsthesia fad of the moment. The method which we find most satisfactory today is carried out as a routine in the following manner:

*First step* The patient under the partial influence of a basal anæsthesia is placed upon the table and the four sites of injection marked with pen and ink. (Numerous dissections made by Dr. George A. Seib, instructor in anatomy, Washington University School of Medicine, demonstrated the advisability of locating the sites of injection at the points chosen.) These tiny cross marks are not obliterated by the subsequent measures to insure skin asepsis unless some water soluble antiseptic be used something which we do not find necessary. Points for injection

are determined as follows: posterior border of sternomastoid muscle is very carefully marked along the edge of a small ruler the ends of which are placed on the appropriate anatomical landmarks on the skull and clavicle exactly half the distance between these two points is then determined and a cross mark made the anterior border of the sternomastoid is then determined in much the same manner and carefully marked along a 'straight edge' a cross mark is made at a point slightly lower than that on the posterior border of the muscle about on a level with the laryngeal tubercle and just above the lower border of the thyroid cartilage which can be plainly felt.

*Second step* The skin of the neck is cleaned up with benzine and sterilized by spraying upon it merthiolate, a superficial soap and water cleansing having been made before the patient is brought to the operating room.

*Third step* The patient is draped as for operation leaving the four tiny injection cross marks exposed.

*Fourth step* A light gas anæsthesia is started and carried to the depth at which needle pricks will not be noted. Then through the posterior of these two injection points we block that portion of the superficial cervical plexus which curves around the posterior margin of the sternomastoid at its middle, using about 3 cubic centimeters of 2 per cent procaine without adrenalin, thus securing approximately a one hour anæsthesia of the skin and fat. It is simple enough to get an adequate conduction anæsthesia of the skin covering the thyroid region in the way we have outlined, but it is absolutely necessary in addition that we anæsthetize the three ribbon muscles as well as the fasciæ covering them and connecting the two across the midline. This can be accomplished through the anterior injection point by blocking the branches of the descendens hypoglossæ where the three separate, to enter the muscles just mentioned, in a triangular space bounded by the upper border of the thyroid cartilage above, the sternothyroid muscle and the sternomastoid muscle on two sides. A needle can be inserted into this space through the above mentioned opening directly in front of the sternomastoid at a little lower level than that on posterior border, a like amount of the same drug being used.

*Fifth step* The incision is made, then the mask removed, and usually no more gas employed unless for some reason the patient demands it.

*Sixth step* We also infiltrate each upper pole after its exposure with 2 per cent procaine just before dividing it and sometimes do the same in

the region where the thyroid is attached to the trachea. Thus is a painless bilateral resection operation insured after needle thrusts, four of them made prior to skin incision, the fifth and sixth, after the upper thyroid poles are exposed.

There are individual instances in which it is thought best to use no gas at all—it may be for no more cogent reason than to satisfy the whim of a somewhat unusual patient. In such instances we go to the patient's bedside half an hour before the time set for operation, spray the puncture sites with ethyl chloride, then inject all four areas with nupercaine, 1:1000 solution, then permit her to fall asleep once more, being thus assured of a six hour local anesthesia. This procedure shortens her stay in the operating room; it also decreases the number of technical procedures to which she must submit while there—incidentally about one-half hour must elapse before the full effect of nupercaine is secured.

It is particularly important for the patient under local anesthesia alone that her surgeon be

in possession of the knowledge that pain sense disappears before that of pressure as has been demonstrated by Heinbecker of the Washington University School of Medicine. Herein lies the distinct advantage in many instances of picking up the skin while incising it, thus protecting the deeper tissues against the sensation of pressure which would otherwise be produced. One great advantage in using some type of conduction anesthesia in which no procaine or other solution is seen in the operation field lies in the assurance that there will be no chronic edema or interference with wound healing which have often in the past been urged as objections to a local anesthesia method which depended upon infiltration. Nerve block has an especial indication when one must remove a second lobe during the healing period of a wound made for the primary lobectomy there being several generally accepted reasons why one does not attempt the infiltration of an edematous, or an infiltrated, or a potentially infected area.

THE SURGICAL TREATMENT OF STERILITY CAUSED BY  
OCCLUSION OF THE FALLOPIAN TUBES

CHARLES C. NORRIS, M.D. F.A.C.S. PHILADELPHIA

From the Department of Obstetrics and Gynecology and the Gynecoc Hospital Institute, 1 Gynecologic Research, University of Pennsylvania.

IN the treatment of sterility it is essential to ascertain the cause of the condition. More than one cause may be present. One of the most frequent conditions producing sterility in women is occlusion of the fallopian tubes. About one third of all cases of sterility in women is due to the effects of salpingitis. Inflammatory alterations of the tubes are usually easily recognized by bimanual examination and a more or less characteristic history is generally present. Old small quiescent, flaccid lesions, especially when occurring in women possessing thick or extremely muscular abdominal walls, are more difficult to detect by clinical methods, and cases in which recognition of the occlusion is impossible without the aid of insufflation or salpingography are by no means infrequent. It is particularly in the latter type i.e. the lesions are not especially massive and all active infection has long since subsided that surgical intervention to overcome the occlusion of the tubes is most likely to be successful. Even under the most favorable circumstances, permanent restoration of the patency of the occluded tubes by surgical measures is successful in only a limited number of cases. Although the operative risk is slight the operation is nevertheless a major one and is associated with a small but definite mortality and morbidity. In a certain proportion of cases adhesions reform and occlusion again develops. This may occur during convalescence or less frequently at a later date. Furthermore, patency may be permanent but pregnancy may not take place. Finally the operation is usually not required except for the purpose of making fertility possible.

Only when the following conditions are present should operation be considered. The husband must be fertile the woman must be in the child bearing age. It must be proved beyond doubt that both tubes are occluded. The infection which caused the tubal occlusion must have disappeared. This applies to infections within the tube and also in the lower genital tract. Apart from other well founded objections to operation during the period when viable organisms are present within the tube surgical intervention is at this time certain to be followed by adhesions which usually defeat the ends of the operation and result in re-occlusion of the lumen of the tube.

If as in the case of gonorrhoea infection is present in the lower genital tract but has subsided in areas above the internal os upward extension may occur again at any time and thereby nullify the effects of operation. At least one ovary must be functioning. Even after the most careful pre-operative study the surgeon cannot promise too much not only for the reasons already mentioned but also because conditions may be found after opening the abdomen which make a satisfactory operation almost impossible. On the other hand pregnancy does occasionally follow when least expected. Patients who desire fertility are generally of the intelligent class. It is best therefore to explain the situation and permit them to make the request for operation if they so desire. In performing the operation the utmost gentleness in handling tissue and careful peritonealization is important. Only thin round pointed needles and fine catgut should be employed. Hemostasis is important but as few stitches as possible should be used and when feasible these should be buried. Catgut and small blood clots are fertile sources for the development of postoperative adhesions. It is generally preferable to cut rather than break adhesions. In some instances it is better not to disturb ovarian adhesion if by so doing the blood supply of the ovary is likely to be impaired. It is decidedly preferable to conserve both ovaries and tubes although migration of the ovum from one ovary to the opposite tube may occur. When the uterus is in retroposition this should be corrected at the same sitting. A modified Coffey operation is often satisfactory for this purpose. At all events a form of suspension should be selected which will not result in malposition or dystocia if pregnancy follows. A wide dilatation of the cervix is routinely employed and any cervical lesions should receive appropriate treatment. Erosions are generally best treated with the cauter.

If there has been no amenorrhoea, the patency of the tubes is tested by the Rubin method 3 months after operation and again 6 months later. This is advisable not only to determine the effects of the operation but also because even with moderate pressures this procedure may occasionally overcome light postoperative adhesions and thereby maintain patency. If there is any suspicion of pregnancy being present the patency test is

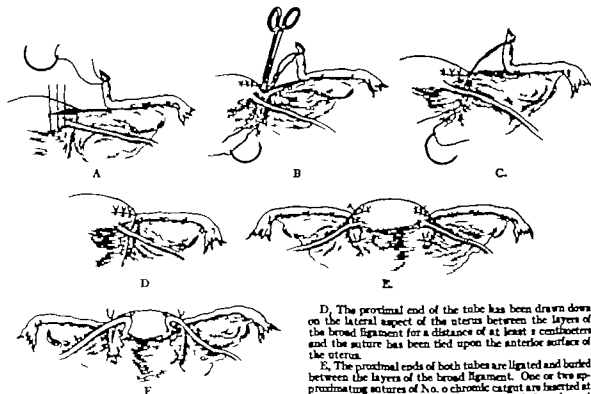


Fig 1. Sterilization. A, Exclusion of the intramural portion of the tube. The proximal end of the tube has been tightly ligated with a fine silk and the ends of the ligature left long. No. 0 chromic catgut sutures have been placed in the uterine wound. (The illustration shows the tube separated from the mesosalpinx for a greater distance than is necessary or advisable.)

B, The sutures in the uterine wound have been tied. The anterior and posterior layers of the broad ligament are being separated with a hemostat close to the uterine wall for a depth of 2 centimeters. The ends of the tubal ligatures have been carried to the bottom of the pocket thus formed and brought out through the uterine wall on the anterior surface, care being taken to carry them well down but not to wound the bladder. The blood vessels may be avoided by placing these sutures somewhat anteriorly.

C, The hemostat has been withdrawn and upon traction of the sutures the ligated end of the tube will be drawn between the layers of the broad ligament.

omitted or delayed and either an Aschheim-Zondek or Friedman test may be employed. In the event of pregnancy following the operation, delivery for many reasons is best conducted in a hospital. The probability of rupture of one of the uterine cicatrices is extremely remote however this is a possibility which should be borne in mind.

I have performed the operation eight times. In this series there was no mortality. Pregnancy followed four times. There were no abortions.

D, The proximal end of the tube has been drawn down on the lateral aspect of the uterus between the layers of the broad ligament for a distance of at least 2 centimeters and the suture has been tied upon the anterior surface of the uterus.

E, The proximal ends of both tubes are ligated and buried between the layers of the broad ligament. One or two approximating sutures of No. 0 chromic catgut are inserted at 4 and 8. These embrace only the serosa of the tube and the myometrium.

F If the uterus is in retrodisplacement and the round ligaments relaxed a modified Coffey operation may be performed as a final step in the sterilization operation. The round ligaments are thus shortened, good peritoneal fixation secured, and the uterus brought into normal position. A continuous Cushing's suture of No. 0 chromic catgut is used for the plication of the round ligaments.

Three patients were delivered by spontaneous labor at term and 1 by an elective cesarean section 2 weeks before the date of expected confinement. In a fifth case one tube was patent 6 months after operation, but pregnancy has not occurred. In 2 cases occlusion of both tubes recurred within 3 months of operation and in 1 case it was not possible to test the patency of the tubes, but as pregnancy has not occurred this case is probably a failure.

No effort has been made to review the literature on this subject, but it is probable that the proportion of successes herein recorded could not be maintained in a large series. The following are the abbreviated histories of the 4 cases in which pregnancy followed the operation. It will be noted that in one of these there was no disease of the tubes, operation for sterilization having been performed in conjunction with a cesarean section.



Fig. 2, A.



Fig. 2 B



Fig. 3 C.



Fig. 3 D



Fig. 3

Fig. 2 A, An elongated tube the seat of an old salpingitis. The infection has disappeared but a few adhesions remain. The lumen in the lower one-third of the tube is obliterated. A syringe point is inserted through the external abdominal ostium and a heavy catgut suture tightly tied around the nozzle to prevent the escape of air. Compression of the syringe (plunger) shows the patent portion of the lumen dilated with air and indicates the extent of the inner portion of the tube which must be excised.

B The shaded portion of the tube indicates the part which is to be excised and the lines of incision.

C, Excision of entire intramural and part of or the isthmus of the tube. It is important that the opening into the uterine cavity be sufficiently large to admit the tube without undue constriction. From the proximal end of the portion of the tube which is to be engrafted a wedge-shaped portion is excised and the tube further split for a distance of about seven millimeters. The split should be directly through the lumen. A No. 0 chromic catgut suture is passed through the upper edge of the wedge and another

through the lower—these are passed into the uterine cavity and the tube drawn into place. Care should be taken so to place these sutures that when tied the split ends of the tube are widely separated insuring patency of the lumen.

D, The obliterated portion of the tube has been excised. The remaining proximal end has been drawn into the uterine cavity and fixed in such a manner that the gaping ends of the wedge-shaped excision are separated. One or two approximating fine catgut sutures at points A and B are generally necessary. These embrace the myometrium and the serosa of the tube.

Fig. 3. Hydrosalpinx. A, The distal end of the tube is obliquely amputated. The syringe test (Curtis test) (Fig. 2 A) is then employed and indicates how much of the isthmus of the tube is to be excised. The dotted lines indicate the lines of excision. B Shows the distal end of the tube has been amputated obliquely and the mucosa and probably a part of the muscularis have been turned back and stitched to the serosa. The proximal end is then implanted into the uterine wound as shown in Figure 3 D

CASE 1. Occlusion of the inner portion of both tubes. No apparent cause for the occlusion.

Age 32 years married for 6 years never employed contraceptive measures. No history of infection except that artificial insemination had been practiced repeatedly for a period of 3 years and that previous to this two dilatation operations had been performed in the hope of overcoming the sterility. Both husband and wife were healthy and athletic.

Pelvic examination showed the uterus in retroposition and the adnexa apparently normal. A suspension operation was suggested. At operation no adhesions were found, but the inner portions of both tubes were thin and cordlike. The outer two-thirds of the tubes appeared normal as were the ovaries. The Curtis test showed both tubes occluded in their inner portions. The occluded portions of the tubes were excised. Implantation was performed and the uterus suspended by the Coffey method. The cervix was widely dilated. Contraception was normal. Neither the insufflation nor lipidol test was employed after operation. Pregnancy occurred 2½ years later and was followed by a normal labor. The infant was normal.

CASE 2. Occlusion of the inner portion of both tubes probably postpartum in origin.

A white Jewess, aged 34 years, married for 10 years. Patient had one living child 9 years of age. She had had no abortions, and never used contraceptives. A history suggestive of a mild postpartum infection was present. There were no symptoms referable to the pelvis since convalescence from childbirth except the sterility.

Pelvic examination showed an apparently normal multiparous genital tract. Insufflation showed occlusion of both tubes. Salpingography showed that the fluid did not leave the uterine cavity. At operation there were practically no adhesions, the body of the uterus was normal, the tubes were unusually long about 15 centimeters in length, the inner third of each tube was rather attenuated and the outer two-thirds appeared normal. The syringe test showed that the occlusion was present in only the proximal one third of each tube. The ovaries were macroscopically normal. Bilateral implantation and routine dilatation of the cervix were performed and a small erosion of the cervix was cauterized. Contraception was normal.

Examination 6 weeks after operation showed an apparently satisfactory result. A Rabin's test was to have been done 3 months after operation, but at this time it was found that the patient's period was 1 week overdue and subsequent development showed pregnancy. This patient was



delivered at term of an 8 pound normal male infant in good condition. Puerperium normal.

**CASE 3.** Small bilateral flaccid hydrosalpinges, probably of gonococcal origin.

Patient aged 36 years, married for 6 years, never pregnant. She had employed various contraceptives for the first year of married life, none since then. History of leucorrhoea beginning shortly after marriage which spontaneously disappeared 4 or 5 years ago. The patient had an attack of what was probably mild pelvic peritonitis about 6 months after marriage, but had no pelvic symptoms since. Husband and wife were in good health. Pelvic examination showed an essentially normal genital tract. There was no evidence of infection, the uterus was forward, movable and normal in size. The adnexa were not palpable and there was no tenderness or induration in either ovarian region. The insufflation test showed occlusion of both tubes. Salpingography showed that no fluid left the uterus. At operation small flaccid bilateral hydrosalpinges were found and a few light adhesions between the tubes and ovaries on both sides. Adhesions were severed, new abdominal omentum were formed, and bilateral excision of the occluded inner portions of the tubes followed by implantation was performed. The appendix showed a few adhesions and was removed. The cervix was dilated. Convalescence was normal. Insufflation tests 3 and 6 months after operation showed both tubes patent. Pregnancy occurred 6 months after operation which resulted in a normal labor at term. A female infant in good condition was secured.

**CASE 4.** Sterilization at time of cesarean section and 3 years later re-implanting of the tubes into the uterine cornua.

Patient aged 34 years, married for 8 years. She had one living child delivered by a cesarean section in another city. She had a moderately contracted pelvis. Two years later a second cesarean section was performed by me which also resulted in a living child. At the request of both parents a sterilization operation was performed at this time by the method herein illustrated. Cesarean section was selected as the method of delivery because of the previous section and the contracted pelvis. For 3 years the patient was sterile and at the completion of this period the couple changed their minds and wished another child. At this time the insufflation test showed no escape of air from the uterus.

At the time of operation only a few light adhesions were found. The ends of the tubes which had been imbedded between the layers of the broad ligaments were found as densely incorporated in the surrounding structures that no effort was made to remove them. The tubes were therefore amputated close to the uterus, tested for patency and imbedded into the uterus. Convalescence was normal and 3 months later insufflation showed both to be patent. Pregnancy occurred 6 months later and a third cesarean section was performed 3 weeks before the estimated date for confinement. A normal apparently full term living infant was secured. A second sterilization was not performed. Convalescence was normal.

SOME POINTS IN THE TREATMENT OF GENITO-URINARY TUBERCULOSIS<sup>1</sup>

T. E. HAMMOND F.R.C.S. CARDIFF WALES

Consulting Urologist, Welsh National Memorial Association Assistant Surgeon, The Royal Infirmary Cardiff

IN men there is an intimate relationship between the urinary and genital organs and it is common for tuberculosis to involve both at the same time in women combined lesions are very rare. It is important to differentiate between tuberculous disease which starts in the urinary tract and extends to the genital organs in 70 per cent of cases, and that which starts in the genital organs and later may involve the urinary tract. This is, however, rare and is seen usually as a terminal event. The former will be referred to as urinary tuberculosis and the latter as genital tuberculosis. These are different diseases and run a different course and require different treatment.

## URINARY TUBERCULOSIS

I have never come across a case of primary tuberculosis of the bladder. The disease begins in the kidneys and in 92 per cent is at the start confined to one. It usually leads to complete destruction of the kidney and involves the bladder and genital system and eventually the other kidney. So long as the disease is limited to the kidney there may be few symptoms and none may have been present even though the kidney is completely destroyed. There may be a little aching in the loin some polyuria giving rise to frequency occasionally there may be a profuse hæmaturia, and very rarely acute renal colic. The bladder has a great resistance to infections, and bacteria may pass over it for years without giving rise to any lesion. Even when infection develops it always has a tendency to heal.

Once the bladder is involved the symptoms change. There is now frequent and painful micturition and a little urgency a little blood may be present at the end of micturition. These symptoms are very slight at the start and may disappear for months. They generally tend to persist and to become more severe but pain is not a marked feature in the early stages. They are sometimes made worse by the administration of hexamine. In my cases the symptoms were present for over a year in 70 per cent before the urine was examined for tubercle bacilli. Even if the patients come for an examination as soon as the bladder symptoms appear and the diagnoses were then made, the chances are that the disease is already advanced in the kidney.

As a rule the patients are extremely healthy. While there may be a slight loss of weight, it is rare that the patient shows any lassitude, has night sweats or an evening rise of temperature. When these are present, the possibility of a primary tuberculosis, of a secondary infection, or some lesion in the lung must be considered. Loss of weight, lassitude, and a poor appetite suggest the onset of a uræmia. Even when both kidneys are involved it is extraordinary how healthy these patients may remain.

The healthy appearance of those who have uncomplicated genito-urinary tuberculosis must be kept in mind when a patient has a double lesion such as urinary tuberculosis and phthisis. If there is any loss of weight, asthenia, or rise of temperature this is rather to be attributed to the phthisis, and no improvement will follow nephrectomy.

The diagnosis is made by detecting pus and tubercle bacilli in the urine and by cystoscopy. A guinea pig should also be inoculated if there is any doubt. It is not common to have large amounts of pus in the urine often it appears clear.

The tubercle bacilli should be sought for by a skilled bacteriologist. In a suspicious case at least three examinations should be made. If the lesion in the kidney is closed (8 per cent of my cases) no pus or tubercle bacilli may be present in the urine. These can be diagnosed only by cystoscopy.

Through the cystoscope the whole of the mucous membrane may be examined. If tubercles, a superficial ulceration, a golf hole orifice or a retracted ureteral orifice are seen one can be quite definite that the condition is tuberculous. This was possible in 75 per cent of my cases. If there is a closed tuberculosis it can be seen that no urine is coming down from this side and from the condition of the ureteral orifice or from scarring in the bladder it may be possible to say that this is due to tuberculosis. If a 4 per cent solution of 0.4 solution indigocarmine is injected intravenously it should appear from a normal kidney within 4 minutes. This test is not of much value if it is delayed from both kidneys as the patient may have an idiosyncrasy to the drug and its elimination is particularly interfered with if a general or spinal anaesthetic is given. But if

there is a delay in its appearance from one kidney it is strongly suggestive of disease in that kidney and even with an early tuberculosis the elimination of indigocarmine is impaired.

In recent years the discovery of uroselectan by von Lichtenberg has been of much help in showing up the changes that are taking place in the kidney. It will show up the outline of the calyces and of the pelvis and will reveal small cavities. It will not reveal lesions situated deeply in the kidney unless these are large enough to deform the pelvis, nor early lesions in the mucous membrane. Since the introduction of uroselectan, an ascending pyelography is rarely necessary.

With these combined methods it should be possible to diagnose every case of urinary tuberculosis. A secondary infection may obscure the picture. The possibility of a tuberculous lesion must always be borne in mind when these cases are intractable to treatment or tend to recur.

Nephrectomy is the routine treatment for tuberculosis of the kidney in all countries of the world. The end-results are excellent if the other kidney is free from tuberculosis and its function is sufficiently good to enable it to carry on the function of the body by itself.

#### THE INVESTIGATION OF THE SECOND KIDNEY

The methods of examining the function of the second kidney have become so exact that it can be said that no patient should die of uremia after a nephrectomy. This is largely responsible for the improvement in the statistics for nephrectomy at the end of the last century the mortality was 25 per cent, now it is 2.5 per cent. It is essential not to expect obvious signs of renal failure but to look for and to pay the closest attention to the slightest changes from the normal.

The urine from the healthy kidney is collected and examined for pus and tubercle bacilli. It has been suggested that it should be injected into a guinea pig; as one tubercle bacillus is sufficient to kill a guinea pig this is too delicate and is, in my experience unnecessary. If either pus or tubercle bacilli are found, the kidney must be assumed to be tuberculous. But even when the kidney is healthy these may be present owing to a flaw in the technique of which the following need consideration.

1. As the catheter passes through the bladder some of its contents may be collected. To prevent this a syringe is attached to the end of the catheter and sterile fluid is injected until the eyes have passed beyond the ureteric orifice.

2. The contents of the bladder may pass up the ureter alongside the catheter into the pelvis

of the kidney. This will happen only if there is any tension in the bladder. While the bladder must be distended when an examination is being made, this is inadvisable when the ureteric catheter is being passed, and is not necessary if the position of the ureteric orifice was noted at the time of the examination. If the continuous irrigation cystoscope is used, the injection of fluid under very slight pressure will keep the mucous membrane clear while the catheter is being passed.

3. If the disease has involved the lower end of the ureter in its ascent to the kidney removal of the diseased kidney is not contra-indicated. As the catheter passes up it may collect pus and tubercle bacilli from this area.

4. The presence of a catheter irritates the mucous membrane especially if it has been sterilized in formaldehyde. This seems more likely to arise in tuberculous subjects. As a result leucocytes appear and it is impossible to differentiate between these and pus cells.

It is my practice to allow the first fluid that comes out from the catheter to escape and then to collect 4 cubic centimeters in the first test tube, 4 cubic centimeters in the second test tube, and the remainder in the third test tube. Each of these are examined for pus and tubercle bacilli. If these are present in one but not in all of the specimens, the possibility of some flaw must be considered. If it is not possible to come to a conclusion from the first examination, this must not be repeated until a month has elapsed, for it is impossible to be certain that trauma to the ureter has not occurred and the effects of this may persist for some time.

If the bladder is very irritable it may be impossible to pass a catheter into the ureter. These cases formerly gave rise to considerable difficulty. Uroselectan is of great value in such a case. It is also of value if the examination of the urine from the second kidney has led to any uncertainty. Formerly in difficult cases it was sometimes necessary to catheterize the ureter four or five times. Nowadays it is rarely necessary to do this more than once.

In estimating the renal function, indigocarmine should come through within 4 minutes of its injection, the urea concentration should be above 2.5 per cent (15 grams of urea having been given 2 hours before the examination) and the blood urea should be below 40 milligrams. A normal blood urea does not signify that either kidney is functioning properly but if it is raised, it means that both are diseased and neither can be removed. With a normal kidney, uroselectan should give a definite shadow within 3 minutes.

I have never seen a case of tuberculosis of the kidney associated with any variety of Bright's disease though there is no reason why it should not occur. The signs of this disease will be sought for in the general clinical examination that must always be carried out; its presence would contraindicate nephrectomy.

The general condition of the patient must always be taken into account for a kidney operation is always difficult and causes shock, which is largely responsible for the mortality of 25 per cent. The difficulties that have to be encountered cannot be estimated until the kidney is exposed at operation as so much will depend upon the density of the adhesions that have formed round it and where they are situated. The operation is not an emergency operation and the surgeon must always keep in mind the question, 'Is this patient fit to undergo a major operation?' There is a tendency nowadays to concentrate too much on the state of the other kidney and to ignore the general state of the patient.

#### CAN A KIDNEY IN WHICH NO TUBERCULOUS LESION EXISTS EXCRETE TUBERCLE BACILLI?

It is frequently stated that healthy kidneys excrete tubercle bacilli. In Cardiff I have the help of skilled bacteriologists and tubercle bacilli are not likely to be missed. Yet not one case has been sent to me in which when they have been found in the urine a definite surgical pathological lesion in the urinary tract has not been present. The cases examined are those in which a surgical opinion is required to find out if tuberculosis is present in the urinary tract and whether treatment is indicated. I am rarely asked to see those who are acutely ill of tuberculosis elsewhere or who are dying from tuberculosis itself when lesions are apt to sprang up anywhere. On comparing the accounts of those who have done research work on this it will be found that some claim to have found the tubercle bacilli in the urine in 40 per cent of those who suffer from tuberculosis; others, on the other hand, deny that they are present. There is considerable discrepancy in their results. They do not record whether they are dealing with those who have an active tuberculous lesion or whether the patients are seriously ill and in that condition in which a miliary tuberculosis is apt to occur. There is no reason why the kidneys should be especially picked out, merely because they are excretory organs. If this bacilluria does occur it means that in all tuberculous states there is a bacillæmia, i.e., a condition in which tubercle bacilli are present in the blood stream, and that miliary tubercles are apt to arise in any organ.

This is rarely found except in miliary tuberculosis and in the terminal states.

In all cases of nephritis it is my practice to have the urine examined and to have a guinea pig inoculated. Yet in not one case has this been positive. The term tuberculous nephritis is again coming into use. It is uncertain what this really refers to though it seems to correspond to the *tuberculose rénale non-folliculaire* of French writers. Those who use it seem to suggest that it is possible for the tubercle bacillus to be deposited in the kidney and to give rise to a nephritis without the formation of a tuberculous lesion. I am doubtful if this does occur. A patient with phthisis can have an attack of ordinary Bright's disease; he may have albuminuria due to the toxæmia if this is acute, or to amyloid disease if chronic, or he may develop tuberculous disease of the kidney. But to suggest that tubercle bacilli can be deposited in the kidney and give rise to nephritis without a tuberculous lesion is opposed to our knowledge of the pathology of this organ in general. Though surgeons would do well to keep an open mind on this question of bacilluria due to the tubercle bacillus, it does seem that it is not a question of any practical importance particularly if it is borne in mind that in urinary tuberculosis pus as well as tubercle bacilli must be present.

#### CAN A TUBERCULOUS KIDNEY LESION HEAL?

Many surgeons consider that a tuberculous lesion in the kidney will never heal and though cases have been recorded where this has taken place they are so rare that they can be regarded as the exception that proves the rule. Tuberculous lesions heal in all other organs and there is no reason why they should not heal in the kidney. It cannot, of course, be put at rest as urine is being continuously secreted, but this also applies to the lung where healed lesions are common. Scars are by no means uncommon in the kidney. Were these present in the lung they would be regarded as healed tuberculous lesions. It is difficult to understand why they should always be regarded as the result of emboli when found in the kidney. Tuberculous lesions here do tend to become circumscribed and it is not uncommon to find caseous masses completely encapsulated in fibrous tissue.

But patients do not come for treatment until bladder symptoms have been present for some time and, even when the diagnosis is made as soon as they appear, the probability is that much destruction has already taken place in the kidney and the lesion that is present is a cavity.

Once this has formed it is rare for it to heal unless the organ collapses and the walls come together. In a solid encapsulated organ like the kidney this is not likely to take place. In the case of a cavity in the lung, healing does not take place until the lung has been collapsed by pneumothorax or thoracoplasty. It does not matter that in one the cavity is small and in the other large the important point is whether the organ can collapse so that the walls come together. If this can take place, there is no reason why healing should not follow. When the ureter becomes involved, there is a tendency for it to become fibrosed and to give rise to a stricture this leads to a hydronephrosis and to destruction of the kidney which would also prevent healing. Notwithstanding these points, it is my feeling that tuberculous lesions in the kidney do at times heal and that, if one is certain that the disease is in an early stage, conservative treatment could be instituted.

In 1925 I had 3 patients, 2 men and a woman, in whom there were only slight lesions in the bladder there was very slight delay in the appearance of indigocarmine, and the functional tests of the kidney were good. They were comfortably placed in life and with treatment in a sanatorium and tuberculin the symptoms disappeared and there was no pus or tubercle bacilli in the urine. A cystoscopy was carried out on one subsequent occasion in each. There was again only slight delay in the appearance of indigocarmine and there were no lesions in the bladder. One of the patients died in 1928 of pneumonia, which was not related to the tuberculosis, and the 2 others were lost sight of in 1929, up to which time they had had no recurrence of the symptoms. From the start the general conditions of these patients was good, the disease in the bladder very slight, and the tests suggested that the disease in the kidney was not marked. The renal function tests give some evidence of the progress of the disease, but in this respect they are not too accurate.

Now that excretion urography is available, it is possible to estimate the changes that have taken place at the time of the examination and to note their progress with treatment. In early cases conservative treatment should be given a trial. This must not be taken to mean that this is being advocated as a routine in urinary tuberculosis as the cases in which this should be attempted are very few and must be chosen with the greatest care. It should only be attempted when it is quite definite from the pyelogram that no cavity formation exists. I do not think I have

seen more than 12 cases in which it should have been attempted the 3 cases quoted the 6 early cases treated by nephrectomy to which I shall refer later 3 cases I have seen since 1930, which have not been observed for a sufficiently long period. As 365 cases of urinary tuberculosis have been seen, the proportion where conservative treatment is possible is very small.

#### NEPHRECTOMY

In 1926 I investigated cases that had been operated upon at least 2 years previously. It was impossible to trace half the patients. The mobilization of the population that took place during and after the War had not ceased. Of those whom I could trace I was able to examine only half. That means that with only a quarter of my patients would it be possible to know definitely what their condition was, and for statistical purposes my findings would be valueless. My experience leads me definitely to reject the statistics that are based on replies to letters. It is often difficult enough to come to a conclusion with the patient present. It is impossible when he replies to questions the meaning of which he may be uncertain and the answers to which are liable to vary according to his mood.

It is fortunate that we have the work of Wildbolz,<sup>1</sup> our greatest authority on genito-urinary tuberculosis, to guide us. He has investigated his cases where nephrectomy had been carried out at least 10 years before, and found that 59 per cent were alive and with the exception of 3 they had remained cured of their urogenital tuberculosis. Many of the patients who were dead had died of some intercurrent disease. Nearly all had lost their bladder symptoms and had normal micturition. His mortality was 25 per cent. If no operation was done he found that 57 per cent died within 5 years. So that if the mortality of the operation does seem high, the mortality of leaving the disease eventually is much higher. Of the cases I could trace my results conformed to these.

Much has been written about the treatment of the ureter to avoid infection of the wound and the formation of a sinus. The confusion is due largely to the failure to appreciate that it is necessary to have the patient in as fit a condition as possible at the time of the operation. This should never be done immediately the tests are completed. These tests are a much greater strain than is commonly supposed and impair the general health and the power of resistance. A medical man I know well had his gall bladder investi-

<sup>1</sup>Wildbolz, *Ann. J. Urol.* 1929, vol. 2, 231; *Klinische der Urologie*.

gated by the usual tests, at the end of 2 weeks he was surprised to find that he had lost 10 pounds. For the patient, these examinations are very trying and must be looked upon as a series of minor operations. He requires time to recuperate and it is better to wait for at least 1 month during which time he should receive treatment in a sanatorium. Even a short visit to the seaside makes a big difference. A little care taken at this time will save many months later on. Since I have carried this out none of my wounds have broken down and no sinuses have persisted. It may be said that there is a tendency for the second kidney to be involved during this time but this is theoretical rather than practical, for the extension of urinary tuberculosis is not a rapid process, it is a matter of years not months.

After the operation sanatorium treatment should be carried out for at least 6 months. There is no difference between surgical and medical tuberculosis, and the need for sanatorium treatment is as imperative in one as in the other. Unless this is possible, I am reluctant to operate for tuberculous disease.

When investigating my cases certain points of interest arose.

1 So often it was found that the patient did well when at the sanatorium, but the disease recurred when he took up his former work. If he was able to change this for a more suitable employment he remained cured. Formerly this was possible. With unemployment rampant, it is only the fortunate patient who can now do this. Consequently the statistics for the treatment of tuberculosis are bound to suffer.

2 One patient who had had the kidney removed was doing well until she married a year later and became pregnant. She would not consent to an abortion. She stood the pregnancy well but during the puerperium the tuberculous disease flared up and she died of miliary tuberculosis. This is the only case I have come across where a patient who has had a tuberculous kidney has become pregnant. Three of the patients married but had no children. It was somewhat doubtful whether the trauma that might be associated with coitus might not injure the lesions in the bladder, but these 3 patients were none the worse.

3 The question that is sometimes asked is In genito-urinary tuberculosis may not coitus lead to the development of the disease in the partner? Though this was to be expected I have not so far come across a case.

4 I was surprised to find that where nephrectomy showed an early lesion in the kidney,

the patient rarely did so well. Four of the deaths were in these patients and took place within a year two from tuberculous disease of the lung which was not detected at the time of the operation and was probably not present, as one did well for 4 months and 1 for 6 months before the first lung symptoms appeared. One died of acute miliary tuberculosis coming on 8 months after the operation when the convalescence had seemed normal. One died of tuberculosis of the second kidney there had been no improvement in the bladder symptoms at any time after the operation. I could recollect removing the kidney in only 6 cases in which the lesion was small, and 4 of these had died within a year. This was quite a surprise as I had been advocating early diagnosis with a view to early removal of the kidney. Yet I am now quite definite that these cases do the worst.

The conclusion now come to is that it is bad surgery to try to cure a patient with early tuberculosis by removing the diseased organ.

#### GENITAL TUBERCULOSIS

While great advances have been made in our knowledge of tuberculosis of the urinary tract, a field in which diagnosis has become a fine art, this cannot be said of genital tuberculosis, for its pathology still remains uncertain the diagnosis is as difficult and as inexact as it was 30 years ago and the methods of treatment that are advocated are not consistent.

The views that are held are most confusing and the position is comparable to that of urinary tuberculosis in the days before cystoscopy and catheterization of the ureters were undertaken. At present it is difficult to obtain the secretion of the testes, and impossible to separate that secreted by each. Nor has any substance that can be excreted by the seminiferous tubules and that renders them opaque to X rays been introduced. The introduction of such a medium should be possible if those interested in the chemical side of medicine would give it their attention. When this substance is available a solution of the problem is likely.

A nodule in the epididymis might be due to tuberculous disease or to a bacillus coli infection which is much commoner than is supposed. If the nodule clears up under treatment the diagnosis will always be in doubt. Should it break down to form a sinus it is not necessarily tuberculous, for staphylococcal infections are seen similar to those that are found in the kidney and when they occur usually suppurate. It is often not possible to come to a definite conclusion from

the clinical findings alone. In only 30 per cent of my cases in which there is extensive tuberculous disease of the prostate are lesions present in the prostatic urethra that can be detected by the cysto-urethroscope, and many of these cannot be distinguished from those due to ordinary infections. When the disease is limited to the testis, they are extremely rare. It is only when ulceration takes place into the bladder or prostatic urethra that pus and tubercle bacilli are found in the urine. It is possible that examination of the semen might give more definite results but this is rarely possible. After massage of the tuberculous prostate the amount of pus that can be expressed is not great and it is not always easy to distinguish between the cells of the prostatic secretion and pus cells. Tubercle bacilli can be found in only 15 per cent of the cases and the inoculation of the prostatic secretion is positive only in a few cases more. Massage of the prostate should not be carried out as a routine or on more than one occasion, as trauma of a quiescent tuberculous lesion may light it up.

Tuberculosis of the testis may begin acutely. This was the method of onset in 5 per cent and in 3 of 4 the inflammation subsided and the disease became chronic in the other before this took place, an abscess formed and discharged. Usually it begins very insidiously as a nodule in the epididymis. This may remain quiescent for years, but unless treatment is carried out the tendency is for it to extend and to break down and to form a sinus. In the majority of cases these ultimately heal. It is extremely rare for an abscess to arise in the vesicles or prostate. Apart from cases of genital tuberculosis in boys at puberty which run a very virulent course, I have seen none. In 35 per cent of my cases, nodules are present in both testes at the time of the examination, and in the remainder it develops in 7 of 10 within a year. The disease usually runs a chronic course and having involved two or more areas in the genital tract tends to subside. In some cases it extends locally giving rise to multiple sinuses and it may be necessary to remove the testis. This has taken place in 5 per cent of my cases.

In a proportion of the cases which varies from time to time, tuberculous lesions may arise in other organs such as the lung or death may take place from military tuberculosis or from tuberculous meningitis. To prevent these complications and to rid the patient of a focus of disease, removal of the testis was carried out as soon as the diagnosis was made. It had little effect, so far as the subsequent course of the disease was concerned, and extension to the second testis was

just as frequent. Lesions broke out in the lung, and probably after no operation for tuberculosis are acute military tuberculosis and tuberculous meningitis so apt to arise. This was attributed by some to a loss of the internal secretion, and they have advised the removal of the epididymis alone. Others have considered it to be due to the disease not being completely eradicated and have advised the more extensive operations. These have not found favor in this country and the majority recommend conservative treatment. It is strange that surgeons who are quite definite about the removal of a kidney for urinary tuberculosis fall into such widely divergent schools over the treatment of genital tuberculosis.

#### THE OPERATION OF EPIDIDYMECTOMY

The object of this is to remove the diseased part but to retain the body of the testis which gives rise to the internal secretion. To prevent extension to the other testis the opposite vas deferens is ligatured at the same time. It is claimed that the internal secretion increases the physical and mental vigor as a result of which the patient is able to overcome the disease. In addition a full scrotum would be a comfort and a moral support to a man.

A strange position arose. In the case of the kidney notwithstanding that it is a vital organ, most surgeons are agreed that a partial nephrectomy should never be done, as if any part of the disease was left the operation would fail. No one would sanction opening the kidney as this would infect the whole of the wound. Yet a partial orchidectomy, for that is what epididymectomy amounts to, is advocated by them just to preserve an internal secretion. It usually means that a part of the disease is left behind and a tuberculous organ is incised in an open wound. It is forgotten that in operating for tuberculosis it is not so much an organ that is being operated upon as a particular disease and the principles on which the operative treatment are based should be the same for one as for the other.

At one time I did the operation but gave it up as a sinus often resulted when none had been present before, and the end-results were worse than if the disease had been left alone. My attention was also drawn to cases in which men had had both testes removed in whom there was no impairment of mental or physical vigor and no tendency for the disease to spread. If this was the case when both testes were removed, the removal of one should have no effect. In addition, the nodule that was present in the scrotum after the operation of epididymectomy would be of little

comfort to a full blooded man, and some asked for it to be removed when a sinus persisted. Therefore if an operation upon the testis is indicated it is better to remove it altogether.

The symptoms that persist after removal of a tuberculous testis are not due to the want of an internal secretion, for they are not seen if a testis is removed for malignant disease or as the result of an accident. The prostate is a very sensitive gland which is richly supplied with nerve fibers. When it is the seat of tuberculous disease abnormal sexual sensations are set up and, if the health is poor, these are felt all the more. If the testis has been taken away these symptoms are attributed to its loss, if no operation has been done, to its diseased state and a firm conviction that they will disappear if it is removed. If an epididymectomy has been done, to the part of the testis that has been left behind or to a sinus that persists with the firm conviction that they will disappear if this is removed. Really these symptoms are due to the inflamed state of the prostate and will clear up as the local conditions and the general health improve. Similar symptoms are present in chronic prostatitis due to gonorrhoea.

#### CONSERVATIVE TREATMENT

This is the school to which most surgeons come after they have experimented in the operative treatment of genital tuberculosis. It is realized that with rest, sanatorium treatment, tuberculin and solganol the disease subsides and a cure results. If a cavity forms, a little external pressure can cause it to collapse and the end-results are better than with any form of operative treatment. If an abscess forms the pus is aspirated. If the testis becomes disorganized or if it causes the patient discomfort, it may be removed. With conservative treatment the sinuses tend to heal and if sanatorium treatment can be arranged the spread to the other testis may be avoided, and lesions elsewhere are not so liable to arise. Occasionally tuberculous disease may arise in the lung or death may occur from miliary tuberculosis or tuberculous meningitis. It must not be assumed that if the testis has been removed these would not have occurred. Experience teaches that with the operative treatment they are more common.

When investigating the end-results of cases of genital tuberculosis, it is impossible to come to any conclusions for we are still uncertain of its pathology. It leaves the definite impression, however that with conservative treatment the end results are better than when operative treatment is carried out as a routine. Two points, however need special consideration. In genital tuberculo-

sis it seems to be thought that as the testis is a small organ the effects of the disease can only be small and the same care is not taken at the start as with a case of phthisis. Nothing could be more fallacious for though of course the presence of tuberculosis in one organ may be more dangerous than in another the same general treatment is required from the start. Sanatorium treatment is as much needed for genital tuberculosis as it is for phthisis. It is difficult to fix the testis with strapping but this should be attempted when the patient is kept in bed. A suspensory bandage should be worn when he is up.

Because of the superficial position of the testis, tuberculosis is diagnosed at a stage long before it is possible to do so in the case of an internal organ such as the lung or kidney for here a nodule in this stage would not be detected. In the case of the testis early tuberculosis is being treated. In the case of urinary tuberculosis, even if the diagnosis is made as soon as symptoms appear the disease has generally been present in the kidney for some time and established tuberculosis is being treated. The treatment of one is very different from that of the other.

#### PRINCIPLES IN THE TREATMENT OF TUBERCULOSIS

When a tuberculous lesion arises in an organ it may be regarded from two points of view either as the advance of a disease or as the resistance of the body to an infection. It may be an advantage to a patient to have a tuberculous lesion in an unimportant organ if the tissues can control its progress. By that it is not suggested for a moment that a man with a tuberculous lesion is better off than a healthy man, but that it is better for him to have a tuberculous lesion in the testis, if it is the means of preventing one in the lungs or meninges.

Tubercle bacilli must come from some focus in the body or from some source outside. In a healthy person these will be destroyed by the antibacterial properties of the blood. If the resisting powers of the body are impaired destruction of the bacilli does not take place and they live and grow. If the resistance is very poor, an acute miliary tuberculosis may develop. On the other hand, if the bacilli are deposited in an organ and a tuberculous nodule arises, this nodule means that the progress of the disease is being resisted locally for with the miliary disease none is formed. If the nodule is composed of fibrous tissue the resistance is good and the disease is being controlled and a cure may follow. If the nodule is composed of caseous matter, the out-



the clinical findings alone. In only 30 per cent of my cases in which there is extensive tuberculous disease of the prostate are lesions present in the prostatic urethra that can be detected by the cysto-urethroscope, and many of these cannot be distinguished from those due to ordinary infections. When the disease is limited to the testis, they are extremely rare. It is only when ulceration takes place into the bladder or prostatic urethra that pus and tubercle bacilli are found in the urine. It is possible that examination of the semen might give more definite results but this is rarely possible. After massage of the tuberculous prostate, the amount of pus that can be expressed is not great and it is not always easy to distinguish between the cells of the prostatic secretion and pus cells. Tubercle bacilli can be found in only 25 per cent of the cases and the inoculation of the prostatic secretion is positive only in a few cases more. Massage of the prostate should not be carried out as a routine or on more than one occasion, as trauma of a quiescent tuberculous lesion may light it up.

Tuberculosis of the testis may begin acutely. This was the method of onset in 5 per cent and in 3 of 4 the inflammation subsided and the disease became chronic in the other before this took place, an abscess formed and discharged. Usually it begins very insidiously as a nodule in the epididymis. This may remain quiescent for years, but unless treatment is carried out the tendency is for it to extend and to break down and to form a sinus. In the majority of cases these ultimately heal. It is extremely rare for an abscess to arise in the vesicles or prostate. Apart from cases of genital tuberculosis in boys at puberty which run a very virulent course, I have seen none. In 35 per cent of my cases, nodules are present in both testes at the time of the examination, and in the remainder it develops in 7 of 10 within a year. The disease usually runs a chronic course and having involved two or more areas in the genital tract tends to subside. In some cases it extends locally giving rise to multiple sinuses and it may be necessary to remove the testis. This has taken place in 5 per cent of my cases.

In a proportion of the cases which varies from time to time, tuberculous lesions may arise in other organs such as the lung or death may take place from miliary tuberculosis or from tuberculous meningitis. To prevent these complications and to rid the patient of a focus of disease, removal of the testis was carried out as soon as the diagnosis was made. It had little effect, so far as the subsequent course of the disease was concerned, and extension to the second testis was

just as frequent. Lesions broke out in the lung, and probably after no operation for tuberculosis are acute miliary tuberculosis and tuberculous meningitis so apt to arise. This was attributed by some to a loss of the internal secretion, and they have advised the removal of the epididymis alone. Others have considered it to be due to the disease not being completely eradicated and have advised the more extensive operations. These have not found favor in this country and the majority recommend conservative treatment. It is strange that surgeons who are quite definite about the removal of a kidney for urinary tuberculosis fall into such widely divergent schools over the treatment of genital tuberculosis.

#### THE OPERATION OF EPIDIDYMECTOMY

The object of this is to remove the diseased part but to retain the body of the testis which gives rise to the internal secretion. To prevent extension to the other testis the opposite vas deferens is ligatured at the same time. It is claimed that the internal secretion increases the physical and mental vigor as a result of which the patient is able to overcome the disease. In addition a full scrotum would be a comfort and a moral support to a man.

A strange position arose. In the case of the kidney notwithstanding that it is a vital organ, most surgeons are agreed that a partial nephrectomy should never be done, as if any part of the disease was left the operation would fail. No one would sanction opening the kidney as this would infect the whole of the wound. Yet a partial orchidectomy, for that is what epididymectomy amounts to, is advocated by them just to preserve an internal secretion. It usually means that a part of the disease is left behind and a tuberculous organ is incised in an open wound. It is forgotten that in operating for tuberculosis it is not so much an organ that is being operated upon as a particular disease and the principles on which the operative treatment are based should be the same for one as for the other.

At one time I did the operation but gave it up as a sinus often resulted when none had been present before, and the end-results were worse than if the disease had been left alone. My attention was also drawn to cases in which men had had both testes removed in whom there was no impairment of mental or physical vigor and no tendency for the disease to spread. If this was the case when both testes were removed, the removal of one should have no effect. In addition, the nodule that was present in the scrotum after the operation of epididymectomy would be of little

## DIRECT HERNIA A RECORD OF SURGICAL FAILURES

EDMUND ANDREWS B.A., M.D., F.A.C.S. AND ARTHUR D. BISSELL, M.D., CHICAGO  
 From the Department of Surgery The University of Chicago

THIS paper is written as a protest against the enormous amount of surgery being done for the correction of a condition which is in the vast majority of cases a perfectly harmless one and can scarcely be called a disease. The surgery stands even in a worse light when one faces the undoubted fact that in about one-fourth of the cases the patient is made definitely worse than he was before.

## MAGNITUDE OF THE PROBLEM

The magnitude of the problem can be stated with singular accuracy on account of the enormous number of examinations made by various recruiting agencies and draft boards. Such figures are available in many of the countries of Europe back to the time of the Franco-Prussian War, our own Civil War and finally the Great War. In these latter statistics one may consult a tabulated record of 2 3/4 million men examined between the ages of 21 and 31, 2.08 per cent of whom had hernia. If these figures were applied to the population as a whole it would be apparent that there were in the neighborhood of 2 3/4 million sufferers from hernia in the United States. However when one considers the relative frequency of hernia in the different age groups, it at once becomes clear that the group under ages 21 to 31 shows the least liability to hernia formation, in that hernia is very much more common in the very young and in advanced middle life and old age. The figures in the very young are of no importance to us in this study as direct hernia is practically unknown in infancy and youth. Statistical reports show that hernia is about 50 per cent more common in middle and old age than in the draft age. Thus if the numbers of the various age groups of population are kept in mind it becomes clear that there are probably about as many men over 20 alive with hernia as there are below.

From these data one may calculate the number of sufferers from direct hernia in America. In various clinical reports about one herniotomy out of five is for direct hernia. Women and children in whom hernia is always oblique must be omitted from the series. This leaves us then with an estimation that there are about a quarter of a million individuals with direct hernia and it is difficult to exaggerate the importance of any problem involving such enormous numbers.

## PATHOLOGY

A direct inguinal hernia is such a totally different condition from the oblique type that it is unfortunate that the term 'inguinal' seems to group them together. The direct hernia is a simple dome shaped bulging of the peritoneum and transversalis fascia into the floor of an inguinal canal which is imperfectly formed. It has no relationship to the cord or to weakness caused by the descent of the testes and lies medial to the deep epigastric artery. In other words, it does not come through the internal ring.

In most animals Poupart's ligament runs much more nearly parallel to the longitudinal axis of the body than it does in man and the space between Poupart's ligament and the rectus sheath is a narrow one. In man, however, the wider flare of the pelvis separates these two structures and in the normal individual this defect is filled in by the conjoined tendon and internal oblique muscle. The latter structure takes origin from Poupart's ligament just above the internal ring and arches medially inserting normally into the pubic bone quite close to the lower end of Poupart's. When the anatomy is of this type, it is obvious that there is no hole in the floor of the canal through which a direct hernia could pass and also that the contraction of this muscular aponeurotic sheet would approximate it to Poupart's ligament and thus act as a sphincter by closing the canal.

In a large percentage of individuals, however, the lower borders of this muscle are markedly deficient and in this class fall the sufferers from direct hernia. The aponeurotic or fibrous portion of the insertion is frequently completely absent and the muscle itself, although its origin is normal, instead of having an almost common insertion with the rectus into the pubis, inserts at a variable distance from the pubis on the lateral edge of the rectus sheath. This muscular deficiency creates the so called inguinal triangle which is much more important than Hesselbach's triangle as it represents the exact hole through which the hernia emerges. The inguinal triangle is bounded below by Poupart's ligament above by the internal oblique muscle and medially by the lateral border of the rectus sheath. This leaves then a wide open space the floor of which is made only of peritoneum and transversalis fascia, producing an ideal spot for hernia to occur.

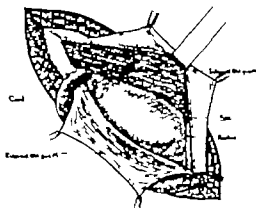


Fig. Direct hernial sac. A simple bulging forward of the floor of the inguinal triangle. This triangle is bounded below by Poupart's ligament, above by the internal oblique and medially by the rectus. The space is wide and the bulging dome-shaped, not allowing any possibility of strangulation.

It is not only the actual hole in the abdominal wall that is important, however, the loss of the mechanical advantages and of the possibility of sphincter action by such a mechanism is obvious. An internal oblique and confined tendon which insert normally can approximate themselves to Poupart's ligament by contraction while the abnormal or deficient ones cannot possibly have such an action. Inserting high up on the rectus sheath as they do contraction of these muscles cannot pull the rigid structures together and all possibility of a sphincter defense is ended. I have measured this in a series of twenty direct hernias and found that the average amount of rectus sheath that bordered the inguinal triangle was 5 centimeters. In other words, the average direct hernia has a lack of 5 centimeters of important tissue and this is certainly its reason for existence.

The sac that bulges through this hole is of course dome shaped. The hole is very large and the peritoneum and transversalis fascia simply bulge forward into it until they encounter the external oblique aponeurotic sheath. Such a sac has no neck and simply represents a wide pocket whose breadth generally far exceeds its depth. As one opens the inguinal canal by section of the external oblique aponeurosis and retracts the cord, this bulging at once becomes evident (Fig. 1). The wall of the sac is made up of peritoneum and covering this is a layer of white, fibrous, connective tissue the strength of which is exceedingly variable. This layer of white fibers tends to become hypertrophied in the case of a direct hernia. It frays out as it passes under Poupart's ligament into the pelvis and becomes very

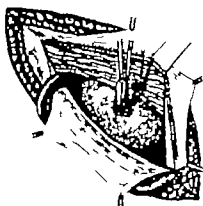


Fig. Direct hernial sac with diverticulum. The fascia covering the peritoneum gives a  $\gamma$  or is congenitally imperfect and the result is an additional bulge in the floor of the canal. There is generally a sharply defined neck to such a diverticulum.

thin. As one dissects up under the internal oblique, there is a very much stronger fibrous element encountered.

This represents the typical pathological finding of a direct hernia. There is, however, another complication which may take place in a small minority of cases. This complication consists in the finding of a hole, generally sharp and discrete, in this fascial layer and a bulging into this hole of a diverticulum of peritoneum which is generally exceedingly thin walled. The hole through which these diverticula emerge is in most cases quite small and the diverticula may reach the size of one's thumb or even larger (Fig. 2). I have found this secondary hernia to take place in less than 10 per cent of direct hernias but it is something that one must always keep in mind as its presence completely changes the prognosis of the case and increases the possibilities for such disasters as strangulation or incarceration. There are two definite types of these diverticula. The first is that which rises within the canal. The second is that which occurs when the direct hernia bulges up to the external ring and as a rare complication, a diverticulum is formed in this area which sticks out through the ring. It is the experience of most surgeons that when a direct hernia does emerge through the external ring in this manner it generally bulges forward or curls up on the abdominal wall and does not have the tendency to descend into the scrotum as does an oblique hernia. Of course the presence of such a diverticulum is a serious matter and its narrow neck may act the same as the internal ring of an oblique hernia and produce constriction of the herniated contents.

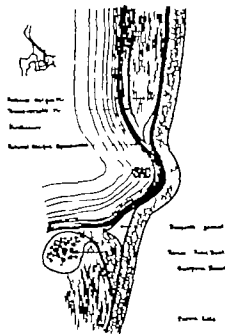


Fig. 3. Sagittal section of direct hernia. Note the wide mouth to the sac. Its very size prevents its passage out through the external ring. Such a condition is nearly always made possible only by the absence of the lower fibers of the internal oblique.

Whether these diverticula are congenital or acquired it is impossible to state although I know of no embryological mechanism which could possibly produce them. The fact that they are not uncommonly reported to present through a well developed conjoined tendon forces one to admit the possibility of a congenital as well as an acquired origin.

#### SYMPTOMS

Pain, as a symptom of uncomplicated direct hernia, has in my experience been exceedingly rare. The more one studies hernias of any type the more one feels disinclined to attribute any symptoms to them. Chronic indigestion supposed to be caused by hernia has in my experience proved very disappointing as it generally persists after the hernia has been surgically cured. This applies to indirect hernia and must be even more true of the direct type. While it is theoretically quite possible that the passage of the viscera into an oblique sac might cause symptoms at first, it is equally true that in the experience of the vast majority of surgeons these symptoms do not occur. In at least 90 per cent of all hernia cases pain is totally absent a most striking evidence of this fact is the large number of hernias found incidentally in routine physical examinations. A doctor finds a hernia oftener than a patient does.

The degrees of distention and tearing necessary for the passage of viscera into an oblique sac is



Fig. 4. Methods of inserting finger into the external ring so as to bring the ball of the finger and not the nail against the floor of the canal. This often permits one to diagnose before operation the type of conjoined tendon one is going to encounter.

nowhere near equalled in the case of the bulging which occurs with the formation of a direct hernia. In the latter no enlargement of the sac or of the surrounding structures is necessary to allow viscera to fall into it. This probably explains the undoubted fact that practically all direct hernias are absolutely painless. It is perfectly obvious from our knowledge of the anatomy of such hernias that there could be no other symptom but pain arising from them so it is unnecessary to carry our discussion of these symptoms any further. The hernias are never large enough to give the "gone" feeling which occurs when a large oblique sac is suddenly filled and it is equally obvious that any effect whatsoever on the intestines or abdominal contents of such a sac is impossible.

#### PROGNOSIS

It is exceedingly difficult to quote exact figures as to the prognosis of direct hernia on account of the fact that too many of them have not been diagnosed before operation. However certain facts are obvious. The first is that the shape of the sac makes strangulation or incarceration impossible. It is wider than it is deep and presents no more danger than any shallow pockets in the abdominal walls (Fig. 3). It is no more liable to cause adhesions to its inner surface than a dozen other similar spots in the normal abdomen. It is perfectly clear that unless a secondary diverticulum is present the prognosis must be nearly 100 per cent safe. Even if a diverticulum is present strangulation is almost unknown. Neither of the authors have ever seen such a case nor is there any record of one in the record of The University of Chicago Clinics 85,000 patients, or of St. Luke's Hospital Chicago last 100,000 cases.

The direct hernia cannot grow to large size. Its mass is far too great to permit it to pass through



Fig. 5. Inguineal invagination, scrotal skin.  
a Oblique hernia: impulse comes down in axis of canal.  
b Direct hernia: impulse comes from floor of canal.

the external ring except in cases of the most extreme dilatation of the ring. The actual statistics of many clinics show that the finding of a complete uncomplicated direct hernia is a real rarity. The pillars of the external ring are very strong and the ring is not more than one tenth the size of the hernia and it is perfectly clear that only in the most exceptional case will the ring be torn sufficiently to permit any subcutaneous herniation. In a recent article summarizing the result of 654 cases of strangulated hernia only 18 were direct. This makes it clear that in any given case of direct hernia the danger of strangulation is practically nil. Furthermore as I will show later, I believe that all cases of strangulation must of necessity occur in the type in which there is an associated secondary diverticulum and I will also show that this type may be diagnosed in advance or at least diagnosed as oblique hernia and thus separated out from the harmless type.

It is clear then that we are dealing with a condition which does not cause pain which does not tend to become worse, and in which involvement of the gastro-intestinal tract is a great rarity and I propose to deny categorically that direct hernia is a disease at all we feel satisfied that it is a harmless condition unless the rare complication of secondary diverticulum of the sac occurs.

#### DIAGNOSIS

In view of the facts already stated the differential diagnosis between direct and oblique hernia assumes a very great importance although it has often been assumed that such a diagnosis cannot be made. It has, however, been my experience that it can be made in a very high percentage of cases if adequate care is taken. Certain facts may be tabulated that will assist in this diagnosis.

1. All women and children may be excluded as its rarity in them is extreme. It is also rare in

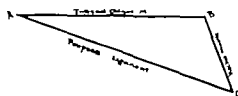


Fig. 6. The inguinal triangle. In order to obliterate this triangle surgically it is necessary to bring point B down to line AC. It is obvious that the entire pull of the rectus muscle is applied to prevent this. Such a closure can be made only by applying tension that argues badly for the permanence of the result.

men under 25 but it is not safe to be dogmatic about them as it is not so exceedingly rare as in women or children.

2. Scrotal or complete hernias may at once be excluded, since, as we stated above direct hernia does not emerge from the external ring.

3. Irreducible hernia may be excluded since the incarceration of a direct hernia is to all intents and purposes impossible.

4. Inspection generally shows the bulging to occur near the pubic spine and not over the internal ring as is the usual case in an oblique hernia.

5. Direct hernias are reduced *instantly* on reclining and the bulging recurs with equal suddenness if the patient strains in the recumbent position. This differential point is based on the fact that the neck of the sac is so wide that any abdominal pressure is communicated instantaneously to the entire wall, whereas, in oblique hernias, time must be given for the omentum or gut to pass through the internal ring which is generally narrow and to reach the different portions of the sac to distend it. If there is the slightest delay in either the appearance or disappearance of the hernia on changes of intra-abdominal pressure it is perfectly clear that the hernia is not a direct one. Besides this, direct hernia will always appear when the patient strains while in the recumbent position whereas many oblique hernias require considerable straining and coughing to bring them out in this position.

6. Most direct hernias are double with the two sides nearly the same and any totally unilateral hernia is almost certainly oblique.

7. Careful examination of the canal in both the erect and recumbent position is important. And it is equally important that the examining finger be introduced into the canal in such a manner that its soft parts, which have the more delicate powers of perception, instead of the fingernail, may be pressed toward the conjoint tendon and the floor of the canal. This may be achieved in the follow-

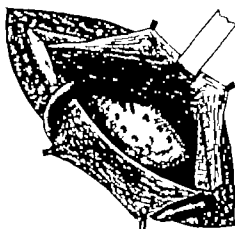


Fig. 7. A small bulging may often be flattened by a single purse-string suture.

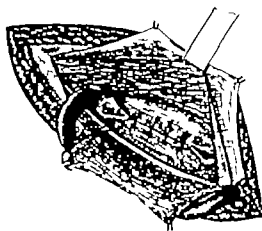


Fig. 8. If the bulge is large, a running stitch inverting the floor of the canal into itself is better.

ing manner (Fig. 4). The patient stands in front of the examiner who uses his left hand for the examination of left canal with the palm toward the patient and the small finger inserted into the left inguinal canal. When the right canal is examined, the right hand should be used. If one is careful, especially if the patient is recumbent, one may feel the conjoined tendon or its absence and the findings of a lax floor of the canal so that the finger may be pushed deeply posterior, are suggestive at once that the hernia is a direct one.

8. When the patient is asked to cough with the examining finger in the canal, the indirect hernia is felt to come from above and laterally downward and to tap the finger on its tip just as if another finger was reaching down to touch it. This is indicative of the sac being an oblique one with the impulse running down in the axis of the canal. In the direct type the findings are very different. The impulse occurs from the floor of the canal and pushes the finger outward. It is diffuse and wide and no finger like projection is felt touching the examining finger.

9. The rare cases of complete direct hernia may often be differentiated from the oblique type in that they tend to bulge forward or curl back onto the anterior abdominal wall, instead of passing directly into the scrotum.

It has been my experience that if these points are kept in mind the uncomplicated direct hernias may be diagnosed in the vast majority of cases without opening the canal. It has also been my experience that in practically all cases where I have made the diagnosis of oblique hernia and have therefore advised operation I have found a secondary diverticulum of the sac. Since these patients present definite surgical indication no harm has been done by the mistaken diagnosis

#### INDICATION FOR OPERATION

From the above it is quite clear that we are dealing with a condition which is in a majority of cases harmless. The uncomplicated direct hernia without a sac or diverticulum can cause no symptoms except pain and this is as above stated, a rare finding. If such conditions as strangulation, incarceration, growth of the hernia and the possibility of its becoming unmanageable do occur (in the cases which are complicated by the presence of a diverticulum of a dome shaped sac), as was stated in the section on Diagnosis, these cases will practically always be mistaken for indirect hernia.

Therefore the indications for operation in the uncomplicated direct hernia may be expressed in a single word. It comes down to the one element—does the hernia cause *pain*? Only hernias causing pain should be operated upon. Any of the other symptoms or complications of the hernia will make it appear to the examiner that an oblique

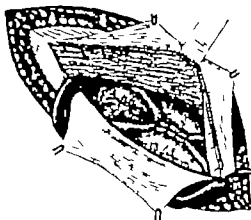


Fig. 9. A second inversion stitch is necessary in many cases to give a firm floor.

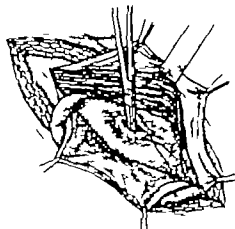


Fig. 10. A diverticulum should be inverted and its neck closed with one or two stitches. Diverticula usually have small necks and few stitches are needed. The edges of the hole through which they come are often well marked and may be seized in clamps and held up.

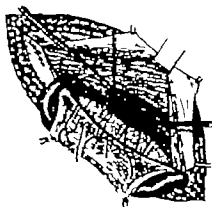


Fig. 11. The transversalis fascia is quite freely movable and may be pulled down without much tension. If the floor of the canal is still weak after the bulge is flattened, it is well to sew the fascia to Poupart's ligament. If the stitches are placed above the other suture lines, the weakened lower portion of the fascia will be pulled under Poupart's ligament.

hernia is present, and these of course have their own indications.

This element of pain must also be carefully evaluated. It is a common experience to find a patient who has never known that he has a hernia to complain of pain or a feeling of weakness as soon as he is informed that a hernia is present. The procedure should then be to explain to him the harmlessness of his condition and tell him to go about his business and thus assure oneself that the pain was not caused by worry and consciousness of a defect. It has been my experience that this is the case most of the time.

One of the most unfortunate aspects of the problem is the medical-legal one. Many of these patients come to the surgeon because they have been refused employment by some corporation on account of the hernia. Assurance by the surgeon that the hernia is harmless and should not be operated upon is useless, as that will not in many cases get the job for the applicant. This is due in part to the hesitancy of the examining physician to recommend the acceptance of the applicant, when many others are available who have no direct hernias. It has been my experience, however, that most examiners for corporations are keenly alive to the situation, but are tied hand and foot by legal restrictions. The normal course of events is that such an applicant should sign a waiver for any future difficulty with the hernia, but numerous court decisions in many states have been handed down to the effect that such a waiver is not legal. Any dishonest applicant may claim that his hernia is made worse by his occupation

and get compensation for it, even though it has been shown to have been present at the time of his employment. The number of such malingerers is so great that few companies dare take the risk. Furthermore there is the very real possibility that the worker may develop the diverticular type. This, while not common, occurs often enough to raise important financial questions, particularly in a disease as common as hernia.

#### OPERATION

*Opening the canal.* The incision in the aponeurosis of the external oblique should always be made at a considerable distance from Poupart's ligament as in these hernias the overlapping of the aponeurosis is indicated whenever possible. The cord should then be elevated from its bed together with all its coverings, in order adequately to expose the floor of the canal, where the sac will lie. Dissection of the cord in its bed can do no good in this type of case, as presumably at least no sac will be found. Furthermore in closure, the stitches should always be placed beneath all the cord structures. Especially careful clearing of the deeper structures about the proximal end of the cord is important in order to expose the deep epigastric vessels. Stitches must be placed in this region and the vessels should be found in order to avoid injuring them.

*Dissection of the cord.* It is important to remember that direct and oblique hernias very commonly coexist and the mere fact that a surgeon finds a direct hernia does not mean that an oblique one is not present. The cord should be

dissected apart near the internal ring in every case and a careful search made for an oblique sac. A surprisingly large number of recurrences following direct hernia are of the indirect or congenital type, and it is perfectly clear that these have been due to the surgeon's overlooking a sac which was there at the time of operation.

*The internal oblique.* A theoretical consideration of the mechanics of the inguinal canal which is deficient to such an extent that a direct hernia may appear reveals at once the futility of the ordinary Bassini type of operation. It is the conjoined tendon which is relied upon in this operation to build up the floor of the canal, and when it is missing the mechanics are so entirely different that they must be carefully studied. In the accompanying diagram it may be seen that any attempt to bring the conjoined tendon or internal oblique muscle *AB* down to the line *AC* (Poupart's ligament) (Fig. 6) brings with it the necessary corollary of attempting to approximate points *B* and *C* on this line. In the ordinary inguinal hernia in which the conjoined tendon inserts down near Poupart's ligament, this may be quite possible. In the type under consideration however it is perfectly clear that if the point *B* is made to coincide with point *C* the entire pull of the rectus muscle is applied to separate them again and in order to accomplish such a purpose it would be necessary to shorten permanently the rectus muscle by the distance of line *BC*, and our common sense tells us at once that this is a hopeless task. The entire pull of the muscle or at least 90 per cent of its fibers are constantly applied to restore the anatomy to its original condition and it is idle to hope that, even if we can temporarily shorten it up in this manner, our stitches will hold permanently.

The result of such stitching is that the grosser structures more or less rapidly resume their former positions after the stitches dissolve. There may be a loss of a centimeter of the edge of the rectus sheath or the conjoined tendon causing a slight enlargement of the inguinal triangle. This in itself is not serious, but in addition it must be recalled that usually some of the deeper tissues have been included in the stitches. When these stitches pull loose there result small holes in the remains of the conjoined tendon or the transversalis fascia and into these holes the peritoneum bulges, making one or more diverticular hernias. Often a large gap in the floor of the canal is created by our stitches in a spot where there was previously only a bulging. It is evident that these new hernias which have a very small neck to the sac bounded by rigid walls would be much more

liable to cause trouble than the condition for which the operation was done. This theoretical possibility is backed up by figures from many clinics indicating that recurrent hernias are especially liable to strangulation. Therefore it is not logical to assume that we may as well have a try at such a hernia the worst that can happen is to leave the patient as he was before. The truth is that in cases of failure (25 per cent) the patient is left very much worse than he was before.

*Use of transversalis fascia.* Therefore new structures have to be sought for accomplishing our purpose. In the absence of the conjoined tendon we have left only the upper fragment of the external oblique aponeurosis to build the floor of the canal such as is used in the typical Andrews imbrication technique, and it is clear that this should be done in every case of direct hernia in which the fibers of the external oblique are not so weakened that it would be futile.

Even with this type of operation, although the external oblique may be then under the cord it is idle to hope that it is really closing the internal ring and besides, it cannot be made to lie deep enough in the canal to close it properly at its upper and inner end. The one substance left which is of any value is the fascial envelope of the abdomen, the endo-abdominal fascia, and it is in the direct hernia that the most use can be made of this structure. As has been described at greater length in previous communications, the endo-abdominal fascia tends to fade out in a very thin, tenuous layer of fibers at the lower end of the canal, but the further one goes from Poupart's ligament, the stronger the structure is. It lies rather loose in the abdomen and may be pulled down and approximated to Poupart's ligament without great tension and in the direct hernia it makes a definite covering of the sac. The first stage, therefore, in the closure of any direct hernia should be an inversion suture placed directly in the floor of the canal (Fig. 7). This inversion suture should be of chromic catgut or some other durable material and should be placed in an oval manner so as to invaginate the dome-shaped bulging into the abdomen until the floor of the canal can be palpated as a flat structure and until it no longer bulges when the patient strains. Sometimes a single suture of this type is necessary (Fig. 8) and sometimes two may be put in if the hernia is an unusually large one (Fig. 9). In the complicated type in which a rupture of fascia has occurred and a diverticulum appeared, this diverticulum need not be resected but may be simply inverted and its neck which is generally quite small, closed with a stitch or two (Fig. 10).



If this inversion of the floor of the canal has been made, it will practically always be apparent that just above the suture line, the transversalis fascia is very much stronger than just below and that this portion of the transversalis fascia may then easily be sutured to the shelving edge of Poupart's ligament without undue tension (Fig. 11). The technique must be varied to suit the individual case and I usually sew this into Poupart's ligament with one row of stitches and the external oblique with another row but it is easily possible in many cases to include them both in the same stitches and thus save a few knots which would lie in the inguinal canal. Following this the cord may be laid back in its bed and the roof of the canal made with the left-over fragments of the external oblique aponeurosis.

*The use of the rectus sheath.* It is at the lower end of the canal at the angle between the rectus and Poupart's ligament that most of our recurrences take place and special care and special precautions are necessary here. A number of methods of making use of the rectus have been described and most of them look better in the illustration than in the actual operation. The easiest, most obvious use of course is to suture the unopened rectus sheath directly to Poupart's ligament but in my experience this has most invariably been accomplished under such great tension that I have felt it necessary to take the stitches out again. Secondly the rectus sheath may be opened by a longitudinal incision and some of the fibers of the rectus pulled out and sutured into Poupart's to fill up this critical gap. Here, too, we are encountered with the doubtful possibility of union between fibrous tissue and muscle even though the tension may be less in this case. I generally make use of some sort of a Haultstad technique turning down a flap of the rectus sheath, and I believe that this should be done in practically every case where the conjoined tendon is deficient. This method, however, is not as strong as it looks in the beautiful illustrations of Max Brödel. The fibers run longitudinally and the flap tends to shred out and split as it is turned over and I am beginning to count more and more on my sutures lying within the canal than I do on any use of the rectus sheath, although I believe it should be used in all cases.

*Fascial transplants* should be used in every case in which the structures about the canal appear weak or in which the edges of the opening come together only under considerable tension. These are best taken from the thigh although the use of preserved fascia has proved good experimentally. It appears to be infiltrated with scar tissue and to

remain in place indefinitely. I have had no personal experience with it.

The important point in the use of grafts is in the correct placing of them. I have seen surgeons lay a fascial graft over the canal when the operation was completed. This can be of no possible use. Such a graft could only tend to prevent the growth of a recurrence already established. The proper place to use a graft is at the innermost possible point so as to prevent a hernia getting started. The graft need never be very large, merely enough to completely fill up the inguinal triangle with about a centimeter to spare around the edges. It should first be tucked under Poupart's ligament and sutured in place there. The medial portion is then trimmed to fit, the rectus retracted and the graft again sutured under its edge. The upper portion generally presents difficulties, as the structures to which it must be sutured are rather vague. If a conjoined tendon is present, it is raised and the graft sutured to its under surface by through and through sutures. In other cases it must be attached to the outer surface of transversalis fascia as high up as possible. The cord may be brought through a slit in the graft which is then closed snugly or it may be left at the outer and upper angle of the wound—never at the pubic end, where most of the recurrences take place.

*Castration.* In bad cases there is no doubt that castration offers a far better prognosis. As direct hernia is a disease of the aged and as the ones operated upon are usually the extreme types, the surgeon should not hesitate to explain to the patient the benefits thus derived. If any hole has to be left for the passage of the cord it is naturally a weak spot where recurrence is likely.

#### RESULTS OF OPERATIONS

The accompanying table hardly requires comment. It includes figures from such well known institutions as Johns Hopkins Hospital, the Massachusetts General Hospital and the Presbyterian in New York, as well as famous clinics abroad. Two things stand out. First, that the results are so bad as to constitute a major surgical scandal. Second, the Bassini type of operation is totally unsuited to such cases. Analysis of the table shows that about twice as many direct hernias recur after Bassini operations as after other types. The best results obtained are those in which a fascial type of operation has been employed.

It is quite striking to note in the table that the only series of cases in which low recurrence rates are reported are those in which the follow-up data were gotten by letter.

TABLE I—RECURRENCE IN DIRECT HERNIA

Author	Date	Per cent recurrence	Cases	Operation
1. Andrews, Billings Hospital	1913	27	28	Various
2. Burrows	1932	22	28	
3. Blake		25		Various
4. Cattell	1931	7.8	51	Fascial repair
5. Dresner	1910	21	28	Bascul repair Hockenbruch
6. Erdman	1923	10.61	213	Various
7. Hoguet	1923	6.4	269	
8. Lamerle	1912	28		Bascul
9. Ledermann	1932	4.1	78	
10. Lyle	1928	9.5	54	Fascial repair Catgut repair
11. Nekfich	1921	23	23	Bascul
12. Taylor	1920	18.03	36	
13. Davis*	1916	8	15	

Total operations, 1545.  
Average recurrence rate, 20 per cent.  
Follow up by letter

When one considers that these recurrences are more dangerous by far than the original hernias, it seems high time that the subject was thoroughly reconsidered.

## SUMMARY

1. Direct hernia is in most cases a harmless condition carrying very slight risk of strangulation, pain, increase in size, or interference with the intestinal tract.

2. Most cases may be diagnosed before operation if proper care is taken in the examination. The few dangerous ones are usually mistaken for oblique hernias which should be operated.

3. The results of surgery are appallingly bad. Operation is indicated only in the group in which a diverticulum of the dome shaped sac is present, and this group is generally diagnosed before operation as the oblique type.

## BIBLIOGRAPHY

1. BLAKE. Quoted by Stetten. *Ann. Surg.* 1923 lxxviii, 48.
2. BURROWS. *St. Bartholomew's Hosp. Rep.*, 1932 lvi 195.
3. CATTELL and ANDERSON. *New England J. Med.* 1931 ccv 430.
4. DAVIS. *J. Am. M. Ass.* 1916 lxxvii, 480.
5. DEUTNER. *Ztschr. f. Chir.* 1919 cl, 7.
6. ERDMAN. *Ann. Surg.*, 1923, lxxvii, 171.
7. HOGUET. *Surg. Gynec. & Obst.*, 1923, xxxvii, 71.
8. LAMERLE. *Deutsche Ztschr. f. Chir.*, 1912, cxix, 569.
9. LEDERMAN. *Ztschr. f. Chir.* 1932 cccxv 659.
10. LYLE. *Ann. Surg.*, 1928, lxxviii, 870.
11. NEKFIK. *Deutsche Ztschr. f. Chir.*, 1921 clxv 34.
12. TAYLOR. *Arch. Surg.*, 1920, l, 382.

## ANALYSIS OF 100 COMPLICATED CASES OF ACUTE APPENDICITIS

## PRIMARY CECOSTOMY OR ENTEROSTOMY AS A LIFE SAVING PROCEDURE

EDWARD RAYMOND EASTON M.D. NEW YORK

AND

WILLIAM JAMES WATSON M.D. NEW BRITAIN CONNECTICUT

VITAL statistics for 1929 show deaths from appendicitis as 15.2 per 100,000 population as compared with 11.8 in 1919 and 9.7 in 1900. This large and steadily increasing mortality has aroused widespread attention and called forth many valuable contributions to the literature. It is generally agreed that the high death rate is due to three major causes:

1. Indiscriminate use of purgatives by the lay public.

2. Delayed operation.

3. Imperfections in operative technique.

The importance of public health education as to the danger of taking laxatives for every "stomach ache" has been stressed repeatedly yet the practice continues among the less educated masses. In a series of 4,470 cases collected by Boland from 8 hospitals in Atlanta, nearly every colored patient had taken large doses of some strong purgative such as castor oil or epsom salts. Fourteen per cent of the colored patients died, as against 3.6 per cent of the whites.

Equal in importance is the length of time between onset of symptoms and operation. The delay usually occurs outside the hospital, and is due to lack of medical advice or to obscurity of diagnosis. This factor like the first, is seen to operate more extensively among the poor and uneducated, for whom medical aid is less readily available. In Boland's series, the average length of time before reaching the hospital was 104 hours for colored patients and 51 hours for whites. Boland believes this long delay coupled with the use of pre-operative cathartics, is accountable for the great mortality from appendicitis among negroes in the South.<sup>1</sup>

The series of 100 cases under consideration here is taken from the records of Knickerbocker Hospital for a period of 2½ years from January 1931 to July 1933. During that time 441 cases of appendicitis of all types were treated, with 12 deaths, a percentage of 2.7. This compares with Flanney's finding of 2.3 per cent mortality in 3,913 cases of all types and Boland's 4.4 per cent in a series which included acute cases only.

<sup>1</sup>Boland points out, however, that while the mortality is high among negroes who have appendicitis, the incidence of the disease is much lower in the colored race than in the whites.

For the purpose of this study 100 of the most seriously complicated cases were chosen. A complicated case, as here considered, is one with a pathological picture of (1) gangrene, (2) abscess, (3) perforation, or (4) acute diffuse peritonitis. In rating the gravity of these various conditions, our observation has led us to place them in this ascending order with acute diffuse peritonitis ranking as the most serious. If a case presented more than one of these conditions, it has been classified under the most severe for example, gangrene with perforation is placed under the head of "perforation." The number of cases and deaths in each group were as follows.

Complication	Cases	Deaths	Cause of death
Gangrene	31		{ Peritonitis Paralytic and septic
Abscess	20		
Perforation	26	4	{ Peritonitis Septic
Acute diffuse peritonitis	3	3	
Total	80		

In 42 per cent of these complicated cases there is a positive statement of pre-operative catharsis. Six of the 12 who died had taken a purgative of some kind.

Among the fatal cases the length of time from onset to operation averaged 27 days. This is only fractionally longer than for the cases that recovered.

While the figures in this series do not in themselves confirm those of Boland and other observers, they seem to show that the two factors of catharsis and delay are of paramount importance in accounting for the high mortality from appendicitis.

In this paper however chief consideration is given to the factor of operative technique. It is desired to call attention to the value of enterostomy as a life-saving measure in a limited number of cases of extreme severity and also to call attention to the fact that this procedure is more likely to be successful if done at the time of the primary operation rather than later on as a secondary procedure.

## IMPORTANCE OF OPERATIVE TECHNIQUE

Appendectomy has now become so common an operation as to be considered within the capacity of the average surgeon. The apparent simplicity of an appendicitis operation, however, is often misleading. It must be borne in mind that, while the removal of the appendix itself is not usually a difficult problem, the proper treatment of its associated complications, either at the time of, or subsequent to the operation requires the exercise of a high degree of surgical judgment if a fatal issue is to be averted. Even in competent hands, the mortality is needlessly high. Thus Fishbein commenting on the 25,000 deaths last year from appendicitis states that four fifths of that number could have been prevented.

The force of this generalization was brought home to the writers by the striking recovery of a patient whose condition had been considered desperate.

CASE No 1541: M. C., female, aged 38 was admitted to Knickerbocker Hospital May 18, 1933. Patient had suffered a dull, aching pain in the right lower quadrant for 3 weeks. The day before admission the pain suddenly became acute and vomiting occurred. Physical examination elicited pain, tenderness, and rebound tenderness over the abdomen more marked over McBurney's point. An indefinite mass was felt in the right iliac fossa. Temperature was 102 degrees, pulse 118. Leucocytes numbered 18,000, polymorphonuclears, 86 per cent.

The case was diagnosed as appendiceal abscess and operation was performed under ether anesthesia.

When the peritoneal cavity was opened through a right rectus incision, cloudy fluid with colon bacillus odor gushed forth. A plastic exudate covered the intestines below the cecum where there was an abscess containing several ounces of thick pus. The peritoneum throughout appeared to be involved in a process of diffuse peritonitis. The appendix had evidently disintegrated entirely: no trace of it was seen, but at its site there was a thickened, angry cecal wall and distended lower ileum. The uterus was large and soft, the adnexa were not seen. Adhesions over the back of the uterus prevented palpation behind it.

The abscess cavity was opened and drained with suction. Drains were placed in the abscess, pelvis and right lumbar gutter, and the incision was closed in layers, with drains in lower angle.

Before the incision was closed, the cecum was brought up through a stab wound in the right lower quadrant and a pursestring suture placed in the exposed area. Within the suture an incision was made and a No. 20 French catheter inserted, after which the pursestring was tied. By a second pursestring suture, the cecostomy was inverted and the cecum pushed back into the abdomen.

The postoperative condition of the patient was good, and she had no distention at any time. The cecostomy began to drain freely on the second day. The cecostomy tube was removed on the third day. Seven days after operation the drains were shortened. There was still a fairly profuse drainage of yellow serous fluid and a slight purulent drainage from the cecostomy wound. At this time there was no fecal discharge. The condition of patient continued good. Twelve days after operation drains were entirely removed and the wound was irrigated with Dakin's solution. The

cecostomy wound was clean and the blood count excellent.

Patient was discharged in good condition June 7, 30 days after admission. Postoperative diagnosis was acute appendicitis, abscess of appendix, acute diffuse peritonitis. One week after discharge both wounds had entirely healed.

Owing to the character and extent of the peritonitis disclosed a fatal termination might have been momentarily expected. It is believed that the primary cecostomy prevented the onset of paralytic ileus and accounted in large part if not wholly for the fortunate outcome.

A review of the 100 similarly complicated cases was then undertaken to determine if possible the factor or factors that led to success or failure in apparently hopeless conditions. A brief résumé follows.

With one or two exceptions, either the McBurney or right rectus incision was used depending chiefly on the preference of the operating surgeon. In instances in which there is no doubt as to the diagnosis of appendicitis the McBurney incision is preferred by the writers as allowing direct access to the affected area and a minimum handling of the intestines.

One to four drains were inserted as the condition required. Routine postoperative treatment was given in whole or part—morphine, codeine, clyaxes, Fowler's position, retention enemas, pituitrin, Levine tube, Murphy or Harris drip.

The original operation was supplemented in 4 cases by a primary cecostomy only. There were 2 cases in which multiple collateral operations were done simultaneously, one, a primary cecostomy and ileostomy, the other, a secondary cecostomy and jejunostomy 7 days after the appendectomy. There were three primary appendicostomies. One patient, who had a primary ileostomy was discharged with an intestinal fistula and returned later for secondary closure. In 3 cases there were secondary ileostomies, performed respectively 4, 5 and 17 days after operation. In five other cases spontaneous fecal fistulae developed at some time subsequent to operation. Details of these cases are given in the following Table I.

As will be seen all of the 18 patients having the supplementary operation of fecal fistula made a good recovery with a single exception. This patient (Case No. 502) had taken cathartics twice on the day before admission. There had apparently been a lapse of 4 days between onset of symptoms and operation but this could not definitely be determined as the patient had been under the influence of alcohol for 2 days. Due to extreme distention following the original operation ileostomy was done 5 days later under local

TABLE I.—ENTEROSTOMY AND FÆCAL FISTULA CASES

Case No. Sex Age	Onset to operation	Cathartic	Pathology	Enterostomy or fistula	Result
10 M 43	4 days	Epsom salts	Acute suppurative, gangrenous appendix	Secondary ileostomy 5 days postop. Local anastomosis	Dead of lobar pneumonia 5 days later
11 M 74	day	No history	Irreducible left inguinal hernia. Gangrene, perforation, diffuse peritonitis	Primary cecostomy	Closed on 26th day
106 F 30	36 hrs.	No history	Gangrene with diffuse peritonitis	Secondary ileostomy 17 days after operation	Closed on 10 days
107 M 19	days	No cathartics	Gangrenous appendix with large fecolith	Fistula on 3th day	Closed on 17th day
113 M 19	3 days	Oil of magnesia	Gangrenous	Fistula on 3d day postop., after secondary operation for postoperative hemorrhage	Fistula closed in 3 days
123 M 20	3 days	Castor oil	Gangrenous and free pus with B. coli, commensals, diffuse peritonitis	Primary cecostomy and ileostomy (anastomosis)	Both closed on 8th day
124 F 69	days	Castor oil	Gangrenous and perforated	Primary appendicostomy	Closed 38th day stoma convalescence
126 M 33	days	Pills and citrate of magnesia	Gangrene and acute diffuse peritonitis	Primary cecostomy	Closed on 26th day smooth convalescence
129 M 5	weeks	Several examined cathartics	Large abscess right iliac fossa. Part of gangrenous appendix found	Fæcal fistula on 26th day	Closed on 14th day
128 M 30	4 days	Cathartic taken, unspecified	Gangrene, acute diffuse peritonitis	Enterostomy (probably ileostomy), primary	Secondary closure 2 wks. after operation. Discharged with fistula. Successful closure and inversion of fistula on later admission
131 M 30	14 days	No cathartics	Gangrene, perforation, ruptured abscess	Primary cecostomy	Closed 2th day
1070 M 33	3 days	Castor oil and other cathartics	Gangrene, perforation, abscess	Primary appendicostomy	Closed 14th day
133 F 14	days	No cathartics	Gangrene, perforation, abscess	Secondary enterostomy on 4th day (ileostomy?)	Closed 20 days after secondary operation
109 M 33	3 days, pain since 12th on abdomen	Cathartic taken, unspecified	Gangrene, perforation, abscess	Fæcal fistula on 1th day with immediate improvement	Secondary closure on readmission 4 months after discharge
1003 M 31	days	Pills water	Gangrene, perforation, abscess	Fæcal fistula 16th day	Closed on 14th day
101 F 28	11 hrs.	Epsom salts	Gangrene, perforation, abscess	Primary appendicostomy	Closed on 8th day
104 M 8	33 hrs.	Cathartic taken, unspecified	Gangrene, acute diffuse peritonitis, cecum markedly distended, intestine covered with plastic exudate. Blood vessels ruptured	Secondary cecostomy and jejunostomy week post operative	Jejunostomy closed after Paine treatment in 7 days. Cecostomy had to be closed secondarily 5 wks later
117 F 28*	3 weeks	No cathartics	Gangrene, abscess, generalized peritonitis	Primary cecostomy	Closed 26th day

\*This case fully described in text

anesthesia. The patient was doubtless suffering from lobar pneumonia when the secondary operation was done, although that condition was not diagnosed until the day of his death, 5 days afterward and 21 days after admission. The pos-

sibility of recovery in this case had the enterostomy been done primarily must be considered.

The only jejunostomy in this series was done a week after operation, in conjunction with a cecostomy which may account for the favorable

outcome. Blake advocates the double operation where indicated, if the stomata are at a distance from each other, and Quain and Waldschmidt sometimes find it necessary to do a multiple col lateral operation with three or even four, artificial openings.

The 6 patients in the entire series who died from acute diffuse peritonitis might likewise have been saved by a primary enterostomy or cœcostomy, since paralytic ileus resulting from peritonitis is usually the direct cause of death in such instances. However, in fulminating cases, this procedure must be supplemented by early, small, and repeated transfusions to overcome the infection. This combined treatment has been seen to produce dramatic effects in certain apparently desperate conditions.

Blake says it is the consensus, if enterostomy is to be done at all, that it should be at the time of the primary operation. He believes it is almost uniformly unsuccessful if deferred but if enterostomy is done early there is no question as to its value, many lives having been saved by such a procedure.

The advantages of primary enterostomy or cœcostomy are (1) that it forestalls the onset of postoperative paralytic ileus a common complication after all abdominal operations (2) that it prevents obstruction from adhesions by keeping the intestine in normal motion and allowing prompt escape of gas and fluid (3) that the wound heals almost as promptly if the proper technique is used as the appendiceal wound, and causes no additional strain upon the patient.

#### FREQUENCY OF POSTOPERATIVE ILEUS

According to Delprat and Weeks, the later occurrence of ileus can be predicted at the time of operation. If abdominal infections have been stirred up or if there has been undue handling of abdominal organs or intestines, one may confidently expect (and, they add, "is seldom disappointed") paralysis of the intestine which lasts a varying period of time. Onset of symptoms is within 12 to 24 hours. Dynamic ileus may develop at any time after operation. A combination of both forms is not uncommon.

Ochsner, Gage, and Garside give a similar opinion. "One must agree with Deaver" say these authors, "that severe acute appendicitis always causes a certain degree of peritonitis." Closely associated with (and usually a result of) peritonitis is ileus. In all cases of peritonitis, especially the diffuse variety, the presence of a greater or less degree of paralytic ileus may be assumed.

It is often found on admission, here as in other hospitals, that the infection is no longer confined to the region of the appendix. Thus, of 193 consecutive cases admitted to the Charity Hospital in New Orleans during a period of 22 months, 29.5 per cent presented localized abscesses, 11.9 per cent diffuse peritonitis and 37.3 per cent required drainage.

According to a compilation, made by these authors, of 6,337 acute cases from nine different sources, 55 per cent of the mortality was due to peritonitis.

Death from peritonitis is due to toxæmia, the toxins being absorbed either from the peritoneal cavity or the paralytic, atonic bowel. By eliminating the toxicity of the bowel through enterostomy, it is possible to compute the percentage of mortality that may be expected from peritonitis alone.

#### TREATMENT

Ochsner holds that the treatment of acute ileus is purely surgical and is best carried out by establishing an enterostomy or a colostomy. Early diagnosis is essential in order that the proper therapy can be instituted before a profound toxæmia supervenes.

The introduction of an enterostomy tube into dilated, atonic gut may be of little value since it drains only a small portion of the intestine in the immediate vicinity. If, however, it is introduced before the dilatation and atony occur it is possible to drain the whole intestinal tract.

Moynihan believes that, in the great majority of cases of ileus the surgeon is called upon too late. "It is not too much to say that in a consecutive series of 20 cases of average intensity

in at least 15 the operation has been too long deferred. He advocates two procedures only in the treatment of postoperative ileus (1) separation of adhesions (when the condition is mechanical) and (2) enterostomy. He uses Coffey's method, a modified Witzel, with the advantage of not producing so great a narrowing of the lumen.

Quain and Waldschmidt report a series of 1000 cases of acute appendicitis in which enterostomy was performed primarily in 31 cases and secondarily in 38. With a few exceptions, the sinuses closed spontaneously. As to the indications for a primary operation they say, "No rule can be formulated as each case becomes a law unto itself but it should be remembered that a properly made temporary opening into the intestines does not injure any of these patients, and that it is the only salvation for many. We have never regretted performing a primary enterostomy, we have often regretted its postponement."

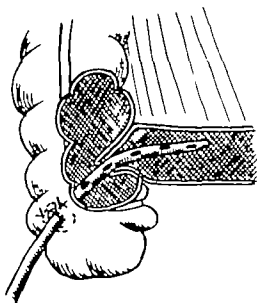


Fig. Cecostomy with ileum drainage.

Wilkie states that cecostomy is unquestionably indicated if, at operation, a grossly distended cecum is found. The comfort this gives, with the ready supply of fluid and absence of violent distention makes it a valuable addition to an appendix operation in selected cases.

The cases selected for cecostomy or enterostomy in the present series were those which, when the abdomen was opened, revealed a dull, lusterless gut distended with gaseous and liquid material and with plastic adhesions between the distended coils which might be expected to develop into obstructive bands and bring about dynamic ileus.

#### CECOSTOMY

The procedure recommended is as follows:

A No. 20 French catheter in which several additional drain holes have been made, is stretched and grooved with a scalpel to form a ring about 8 inches from its rounded tip. A stab wound is made lateral to the operative wound just below or medial to the anterior superior spine, parallel to Poupart's ligament and about one inch above it. The lateral wall of the cecum is drawn through this opening in the abdominal wall. A purse-string suture of No. 0 chromic or Pagenstecher is placed in the wall of the cecum. A small puncture wound is then made in the center of this pursestring area. The catheter is passed through the puncture wound in the cecum and carefully insinuated through the ileocecal valve (Fig. 1). The pursestring is drawn taut and tied

securely at the grooved ring. This area is then inverted with one or two additional pursestrings of No. 0 chromic. The catheter thus placed passes into the lower ileum 4 to 6 inches. The portion of cecum containing the catheter is pushed back into the peritoneal cavity and caught with a catgut suture at each end of the peritoneal incision so as to hold it firmly to the abdominal wall. A silkworm suture is then passed through both edges of the skin of the stab wound and the catheter to hold the catheter in place. The drainage and closure of the appendectomy wound are then concluded in the usual manner.

This technique is the only practicable one for a cecostomy. It is recommended entirely on account of the short period of its subsequent closure, as described in Case No. 1541 previously quoted. In this case drainage of fecal matter had ceased in less than a week, and within 3 weeks the cecostomy wound had closed entirely. This prompt closure has proved to be the rule in other cases similarly treated.

In the case of a jejunostomy or ileostomy, Wangensteen's technique appears to be the most satisfactory. After any existing distention is "milked" or aspirated out, a No. 14 (French) urethral catheter is laid onto the collapsed bowel and a running stitch of No. 000 chromic catgut enfolds the bowel about it over a length of  $1\frac{3}{4}$  inches. A tiny puncture is made and the catheter introduced into the lumen; the fixation stitch is placed and the peritoneal tunnel continued for another  $1\frac{3}{4}$  inches. The suture is then completed. This is, in fact, a modified form of the Witzel method. Wangensteen states that a No. 14 catheter will drain the bowel "as well as a garden hose" which is no doubt correct.

Appendicostomy appears to be a very illogical procedure if early healing is expected, since it goes through a portion of the bowel more likely than any other to have been affected by the associated peritonitis. It is preferable to choose a part of the cecum above, anterior and lateral to the base of the appendix, where the bowel is relatively healthy. This allows the necessary inversion and promotes early healing after the tube is removed.

Whether ileostomy or cecostomy should be used must be decided according to the local pathology present. In cases of diffuse peritonitis, the ileostomy is probably more desirable and undoubtedly where there is extensive dilatation and atony multiple enterostomies, including jejunostomy are indicated. The enterostomy should be performed in a free and unlinked portion of the ileum, at least a foot above the ileocecal

junction. If there is a large localized abscess at this junction a lateral caecostomy with ileum drainage will it is believed bring about very satisfactory results.

It is not intended to recommend herein so radical a procedure as enterostomy or caecostomy in every case of diffuse peritonitis or large abscess. Each case as Quain and Waldschmidt have observed requires individual consideration. If however, their further statement that *they have never regretted performing a primary enterostomy and have often regretted not having done so*, is to receive due weight, it is likely that this operation will be done more frequently in the future than in the past. In a total of 69 enterostomies, 31 of which were primary and 38 secondary these surgeons found it necessary to do a secondary closure of the fistula in but 10 cases.

#### SUMMARY

One hundred complicated cases of acute appendicitis selected for their severity and grave prognosis, have been analyzed. In only one of the 18 cases in which an enterostomy or caecostomy was done or in which a faecal fistula developed spontaneously, did a fatality ensue.

The best results were secured when the colateral operation was done primarily. In these cases, it proved a life-saving measure. In certain

doubtful cases also enterostomy (or caecostomy) as a prophylactic procedure against the development of paralytic ileus seems more than justified. At all events it can scarcely be considered to increase the gravity of appendectomy in the presence of a spreading peritonitis.

The writers wish to express their appreciation to the Surgical Director Dr Ellsworth Eliot, and the Surgical Staff of Knickerbocker Hospital for permission to publish this series of cases and for the many helpful suggestions made by them in the preparation of this paper.

#### REFERENCES

1. BLANK, JOSEPH A. Diseases of the Peritoneum—Peritonitis. Nelson's Loose-Leaf Surgery vol. v p. 21.
2. BOLAND FRANK K. Results in the treatment of acute appendicitis. J. Am. M. Ass., 1932, xcix, 443-446.
3. DIELSPAT G. D. and ALANSON WEXLER. Postoperative intestinal obstruction. Am. J. Surg. 1930, viii, 1189.
4. FIDOREY J. M. T. JR. An analysis of complications and deaths occurring in appendicitis. Am. J. Surg. 1933, xx, 773-799.
5. OCHSNER, ALTON. Intestinal Fistulae. Nelson's Loose-Leaf Surgery vol. v.
6. OCHSNER, ALTON. GAGE, I. M., and GARSTIDE, EARL. Intra-abdominal postoperative complications of appendicitis. Ann. Surg. 1930, xci, 544.
7. QUAIN, E. P. and WALDSCHMIDT R. H. Acute appendicitis, with a report of 1000 consecutive cases. Arch. Surg., 1928, xvi, 868.
8. WILKIE, D. P. D. Mortality in acute appendicular disease. Brit. Med. J. 1931, i, 253.



TOTAL REMOVAL OF LEFT LUNG FOR BRONCHIECTASIS<sup>1</sup>

CAMERON HAIGHT, M.D. AND ARNOLD, MICHIGAN

From the Department of Surgery, University of Michigan

**I**N occasional cases of non-tuberculous pulmonary suppuration or neoplasm, complete removal of the affected lung offers the most certain and, at times, the only means of cure. The feasibility of resection of an entire lung has been demonstrated experimentally by many investigators, several of whom achieved notable success. The clinical application of this procedure, however, has been unsuccessful except in the single instance of Nissen, who, in 1931, resected the entire left lung for bronchiectasis.

In the patient who is the subject of this article the delayed removal of an aspirated foreign body resulted in a widespread pneumonitis and bronchiectasis of the left lung. Soon after the removal of the foreign body the patient developed a spontaneous tension pneumothorax and an acute empyema which required immediate airtight drainage of the pleural cavity. As conservative measures and, later, an extensive thoracoplasty were unsuccessful in relieving the symptoms of the severe residual bronchiectasis, complete removal of the affected lung was finally undertaken. The detailed history of the case follows.

## CASE REPORT

Vivian L., aged 13 years. The patient had been in good health prior to the onset of the present illness on January 5, 1932, at which time two teeth were extracted under gas anesthesia. During the extraction the mouth was held open by mechanical apparatus. On regaining consciousness following the anesthesia, the patient complained of a tickling sensation in the throat, followed by a severe attack of coughing, nausea, and vomiting. The symptoms of a severe pulmonary suppuration soon developed. Roentgenograms taken 3 weeks after the onset of the illness showed an infiltration of the greater portion of the left lung, a foreign body in the left main bronchus, and a pleural reaction as of effusion. Although thoracostomy was performed on three occasions, no pleural fluid was obtained.

On February 7, 1932, 33 days after the onset of the illness, the patient was admitted to the University Hospital. She was acutely ill, coughing severely and expectorating large amounts of foul sputum. Examination of the chest revealed immobility of the left side, flatness, absent breath sounds, and tactile fremitus except in the left axilla. The physical findings were those of an occlusion of the left primary bronchus with a drowned lung. There were no abnormal physical findings in the contralateral lung. The rectal temperature was 36 degrees F, pulse, 140, and respirations, 60. The leukocyte count was 350. On roentgenoscopic examination by Dr. Carleton B. Peirce, the left thorax appeared to be almost uniformly obscured except for several patchy air-containing areas in the upper lobe at the level of the hilum. Roentgenographic examination made through a Potter Bucky diaphragm revealed a

shadow of soft tissue density situated in the region of the left main bronchus. The roentgen diagnosis was a foreign body in the left main bronchus with resultant pulmonary suppuration and pleural effusion.

A bronchoscopic examination was performed by Dr. A. C. Furstenberg on the day of admission. A foreign body surrounded by granulation tissue was observed in the left primary bronchus. Immediately following its removal, an enormous quantity of very foul, thick, yellow pus was liberated. The amount was so great that it could not be aspirated through a suction tube and much of the pus flowed into the right primary bronchus, greatly embarrassing the child's respirations. For several hours following removal of the foreign body the patient was exceedingly cyanotic and death seemed imminent. On inspection of the foreign body it proved to be a piece of black rubber (1.7 centimeters by 1 centimeter by 0.6 centimeter), which had become dislodged from the mouth gag during the extraction of teeth.

The patient condition remained critical. Despite postural drainages every 3 hours, she continued to expectorate large amounts of foul smelling pus in the later weeks between drainages. There was a constant temperature elevation of from 101 degrees to 103.6 degrees F by rectum. Roentgenograms taken 6 days after the bronchoscopy showed a pneumonitis of the central portion of the right lung and only slight clearing of the infiltration in the left upper lobe. The lower half of the left thorax presented a uniform opacity. On the following day, thoracostomy was productive of 5 cubic centimeters of thin, straw colored, sterile fluid. It was planned to treat the pulmonary suppuration by bronchoscopic aspirations, and on February 20, this was begun.

On March 2, 1932, the patient suddenly became dyspneic and cyanotic. A diagnosis of perforation of the left lung with a spontaneous tension pneumothorax was verified by thoracostomy, which revealed the presence of a large amount of foul smelling air under positive pressure. Air and considerable thick, foul, yellow pus containing spirilla, fusiform bacilli, and various pyogenic organisms were aspirated. Intercostal airtight drainage of the pleural cavity was immediately instituted and constant suction was applied to maintain expansion of the lung. It was necessary to keep the patient in an oxygen tent for 4 days, during which time there was gradual clinical improvement, although roentgenograms demonstrated a pneumonic infiltration in the lower half of the right lung. Two blood transfusions were given and an abscess which developed beneath the extracostal muscles at the site of the last thoracostomy was drained.

The pneumonic process in the right lung cleared gradually and the empyema cavity decreased rapidly in size. The pulse, temperature, and respirations remained elevated and the daily amount of sputum varied between 40 and 90 grams. On March 20, 1932, a temporary surgical interruption of the left phrenic nerve was produced. The patient continued to cough and expectorate foul sputum at frequent intervals and at times the cough was so severe that it provoked vomiting.

A series of four bronchoscopic aspirations was begun on April 6 and postural drainages were given at frequent intervals during the day and night. At each bronchoscopy copious amounts of purulent secretions were aspirated,

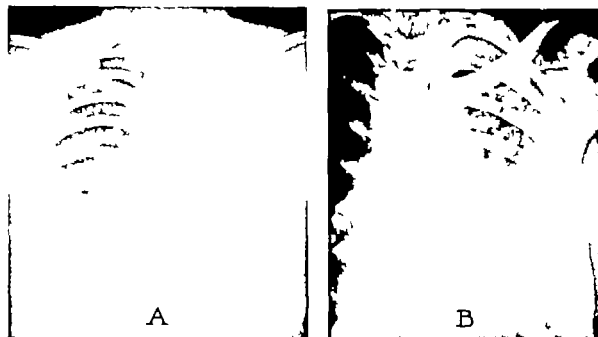


Fig. 1 A, July 3, 1932. Roentgenogram routine technique, prior to thoracoplasty. The gross infiltration of the left lung is partially obscured by pleural thickening, resulting from the healed empyema. The pneumonitis that was present in the right lung several months earlier has now cleared. B Same date. Roentgenogram, Potter Bucky technique, demonstrates multiple small cavities throughout the left upper and lower lobes.

especially from the left lower lobe bronchus. The lumen of the left lower lobe bronchus was slightly narrowed by granulation tissue, but there was no apparent stenosis of the left main bronchus. Lipiodol was injected bronchoscopically but the resultant filling was unsatisfactory. A third blood transfusion was given. As *apiochrome* and *fusiform bacilli* were demonstrated in the sputum, a course of six injections of *neoursphenamine* at weekly intervals was started on June 14, but no beneficial effect was noted. The empyema cavity had become obliterated and the small remaining sinus in the thoracic wall closed within several weeks.

Although there had been some improvement from the conservative management of the pulmonary suppuration, the patient's general condition became stationary. The temperature showed a slight daily elevation, the pulse rate varied from 90 to 140, and the respirations from 20 to 30. There was an average daily expectoration of 190 grams of foul, purulent sputum. Physical and roentgen examination (Fig. 1) showed extensive disease of the entire left lung. By the use of the Potter Bucky diaphragm numerous small abscesses, presumably bronchiectatic, were seen in the left upper and lower lobes, although visualization of the latter was greatly obscured by pleural thickening. The pneumonitis in the right lung appeared to have cleared completely. It was felt that an extensive staged thoracoplasty offered a chance of collapsing the numerous small cavities. As a thoracoplasty involved less risk than a pneumonectomy it was decided to postpone the latter and to use it only in the event that the thoracoplasty should be ineffective.

As a preliminary measure to the thoracoplasty a parasternal division of the first to fourth costal cartilages was done on July 30, 1932, so that the anterior rib stumps remaining after the thoracoplasty would be free to swing medially thereby increasing the thoracoplastic collapse. At about 17 day intervals, moderate lengths, 110.5 centimeters, of the first to eleventh ribs were resected posterolaterally in

four stages. The thoracoplasty was completed on September 20, 1932. The patient withstood the many stages remarkably well, although the pulse rate became quite rapid during each procedure. As a supportive measure, two blood transfusions were given during this period.



Fig. 2 October 15, 1932. Roentgenogram Potter Bucky technique, after completion of a moderately extensive posterolateral thoracoplasty and 3 weeks prior to pneumonectomy. The collapse of the thoracic wall is unsatisfactory and the multiple cavities in the left lung persist.

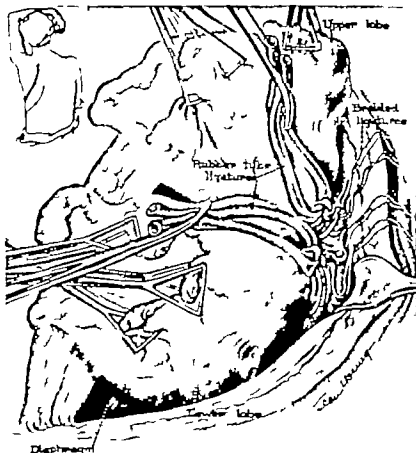


Fig. 3. Technique used in the ligation of the left upper and lower lobes during the second stage of the pneumonectomy. Both lobes have been completely separated and the interlobar fissure has been opened. The pedicle of each lobe has been ligated with heavy doubled braided silk and a rubber tube. The pneumonectomy was performed through the upper thoracoplasty incision (inset). The black dot in the lower thoracoplasty incision indicates the location of the intercostal tube for airtight drainage of the pleural cavity. Continuous drainage of the pleural cavity instituted at the first stage of the pneumonectomy was maintained until the eleventh day following the second stage.

The result of the thoracoplasty was not satisfactory. The general condition was somewhat improved but the patient continued to cough severely raising about 40 grams of foul, purulent sputum daily. On October 3, 1932, roentgenograms (Fig. 2) taken with the Potter-Bucky diaphragm after completion of the thoracoplasty demonstrated multiple residual areas of decreased density throughout the entire left lung field which showed gross infiltration. The appearance was one of multiple small abscesses. A right dorsal and lumbar scoliosis which had developed prior to the thoracoplasty was only slightly increased by the operation.

As several attempts to introduce lipiodol by the supraglottic route had been unsuccessful, it was considered to secure a satisfactory filling by means of an intratracheal catheter introduced with the aid of a laryngoscope. With the patient reclining on her left side, lipiodol was injected through the catheter and its progress was observed roent-

genoscopically. The lipiodol failed to flow into the left main bronchus, instead, it flowed upward into the right lower lobe bronchus. From this observation, a stenosis of the left main bronchus was suspected, this was confirmed by bronchoscopic examination on October 3, 1932. At a distance of 3 centimeters below the carina, the left main bronchus was greatly narrowed. The stenosis admitted a No. 4 F bougie but there was definite resistance felt on withdrawing the bougie. Due to the presence of a partial stenosis, it was believed that further improvement of the suppurative bronchiectasis could not be expected. Accordingly, total left pneumonectomy was decided upon, as it was believed that a complete removal of the diseased lung offered a more certain means of cure than would either a wide cavity drainage or an anterolateral thoracoplasty. It was feared, however, that the pleural adhesions resulting from the empyema and the thoracoplasty might prove inseparable. The vital capacity was recorded before the

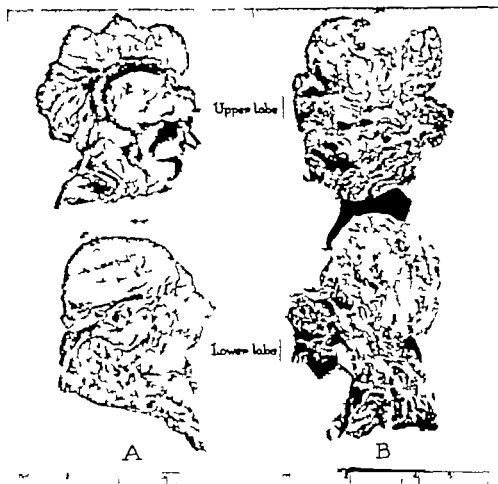


Fig. 4. A Medial surface of the greatly shrunken and necrotic upper and lower lobes which separated spontaneously 16 and 17 days, respectively after ligation at the second stage of the pneumonectomy. The upper lobe ligatures are still attached to the lobar pedicle. B, Cross section of both lobes reveals small bronchiectatic cavities, considerable fibrosis, and lack of normal, air-containing tissue.

pneumonectomy but unfortunately this observation is missing from the patient's chart. However I am under the impression that it was 1,250 cubic centimeters, 49 per cent normal (Stewart).

*First stage pneumonectomy November 8, 1932* Nitrous oxide and oxygen anesthesia was used. During the few hours immediately before operation, several postural drainages were given at frequent intervals, so as to empty the bronchiectatic pockets as completely as possible. The patient was placed on her right side, on an inclined table with the head lowered about 25 degrees. The upper stage posterolateral thoracoplasty incision was reopened and the incision was extended inferiorly and anteriorly. The regenerated fourth, fifth and sixth ribs were resected and the anterior stumps of these ribs were removed to the midaxillary line. When the parietal pleura was incised, the lung was found to be grossly adherent to the thoracic wall. The pleural adhesions were readily separable by blunt dissection. The lower lobe was congested, considerably decreased in size and firmer in consistency than normal. It was freed from the thoracic wall, the diaphragm, and partially from the upper lobe. No attempt was made to divide the pulmonary ligament of the lower lobe or to separate the upper lobe as the pulse rate, which was 138 at the beginning of the operation, had increased to 168. A fenestrated tube for airtight drainage of the pleural cavity

was introduced through an intercostal stab wound at the level of the costophrenic angle, and the main incision was closed.

The immediate postoperative recovery was satisfactory and on the following day a transfusion of 400 cubic centimeters of blood was given as the hemoglobin had decreased from 76 per cent to 54 per cent (Sahli). The highest postoperative temperature was 100.4 degrees on the first postoperative day and on the succeeding days there was about 1 degree of elevation.

*Second stage pneumonectomy November 14, 1932* The second stage of the pneumonectomy was performed 6 days after the first stage. Postural drainages were again employed before the operation. The position on the operating table was the same as that employed at the first stage. Nitrous oxide anesthesia was again used. The incision was reopened, the intercostal drainage tube removed, the lower lobe was freed from its newly formed adhesions, and the pulmonary ligament was divided. The lower and upper lobes were completely separated at the interlobar fissure.

As the patient's condition had remained satisfactory separation of the upper lobe was then begun. The adhesions about the upper lobe were more dense than were those about the lower lobe but with some difficulty they were completely separated. It was necessary to free the mediastinal surface of the lobe above its hilum before separation of the



Fig 5 December 9, 1938 Roentgenogram 3 days after total removal of the left lung. The residual pleural defect is indicated with pencil line.

ery adherent, per could be carried out. Both lobes were thus completely freed and a satisfactory pedicle to each lobe was developed. As the mediastinum had become somewhat thickened by the preceding empyema, it was necessary to use only mildly positive pressure anesthesia during and after separation of the lung.

It had been planned to enclose the lung in rubber sheeting (a very thin bathing cap had been procured for the purpose) in order to await further reaction of the mediastinum and formation of a protective inflammatory reaction of the parietal and mediastinal pleurae before proceeding with ligation of the lobes. This plan was abandoned for the following reasons. The mediastinum was already partially hard; a small tear had been accidentally made in the lower lobe, exposing the pleural cavity to infection, and most importantly because it was felt that gauze packing was essential to control the considerable oozing from the parietal pleural surfaces. The pedicles of both lobes were ligated separately with an encircling mass ligature of heavy braided silk placed close to the junction of the lobes. An elastic rubber tube ligature was tied around each pedicle slightly distal to the braided silk, in order to maintain continuous strangulation of the lobes as the tissues receded from the silk ligatures (Fig 3). An additional braided silk ligature was placed distal to the rubber tube ligature around the lower lobe pedicle (not illustrated). During ligation of the lobes, no cardiocirculatory or respiratory changes were observed. The lobes were not excised but they were allowed to become necrotic and eventually sequestrate when the ligatures cut through the pedicles. Gauze soaked in acriflavine solution was wrapped loosely about both lobes in order to control the oozing, to stabilize the mediastinum, and to prevent the necrotic lung from becoming adherent to the thoracic wall. Two irrigation tubes were inserted through the incision, the airtight intercostal drainage tube was reinserted, and the wound was again tightly closed. The long ends of the ligatures around the lobar pedicles were brought through the wound and they were anchored externally with clamp. The patient

withstood the procedure remarkably well. The systolic blood pressure during the operation remained elevated above 100 millimeters, and although the pulse rate increased from 120 at the beginning of the operation to 170 at its conclusion, there was no shock. The duration of the operation was one hour and five minutes.

**Subsequent course.** The immediate postoperative convalescence was thoroughly satisfactory. The pulse rate varied between 60 and 140 and the lowest systolic blood pressure (observed at 15 minute intervals) was 96 millimeters. There was no delayed shock or vomiting and the patient took fluids freely by mouth. A very small amount of slightly bloody sputum was raised immediately following the patient's return to her room. Although she was subsequently encouraged to cough at frequent intervals, she could raise no sputum, as the ligatures had completely occluded both lobar bronchi. A blood transfusion was given about 8 hours following the operation, as the preoperative hemoglobin had been 60 per cent and the red blood cells 3,460,000. The pleural cavity was irrigated twice daily with acriflavine and later with Dakin's solution. The temperature which reached 102 degrees F on the first day after operation, rapidly subsided during the following days to 99 degrees. A urinary infection developed on the first day after operation but it likewise soon subsided.

On the fourth day the wound was reopened under nitrous oxide anesthesia and the intrapleural gauze packing was changed. Both lobes were shrunken and dark and were in a state of dry gangrene. As the mediastinum was somewhat mobile, it was stabilized by anchoring the long ends of the rubber tube pedicle ligatures to the rib immediately below the incision. Gauze was again placed loosely about the lung and the wound was packed wide open with acriflavine gauze. A firm dressing was applied. A smear and culture of the secretions within the pleural cavity showed *Staphylococcus aureus* and *Bacillus pyocyaneus*. The convalescence continued to be satisfactory. Seven days later the gauze packing around the lung was again changed under gas anesthesia and the necrotic lung was slightly exteriorized by the packing. The lobes had further decreased in size and at this time, 11 days after operation, no bronchial fistula had yet appeared. On the sixteenth day after operation, the upper lobe was found lying loose in the wound and it was removed. The lower lobe sloughed off on the following day.

The gross examination of the greatly shrunken and necrotic lobes was reported by Dr. L. A. Bruns as follows: The upper lobe measures 6 centimeters by 4.5 centimeters by 3 centimeters, weight 25 grams. There are ligatures about the hilum and bronchus which have contracted to form a fibrotic mass. The lung itself is composed of a necrotic, pale yellowish green tissue which has a fleshy consistency. The cut surface shows small cavities varying in size from a few to several millimeters. One cavity is 1 centimeter in diameter and an oval bronchiectatic cavity measures 6 millimeters by 4 millimeters by 3 millimeters. The cut surface also reveals the major portion of the lobe to be composed of scar tissue. The lower lobe is composed of the same fleshy, fibrotic tissue which is necrotic and contains smaller cavities which are very scant in their distribution (Fig 4). The microscopic examination was reported by Dr. J. C. Bugher: The upper lobe presents a moist gangrene involving the entire lobe. Multiple bronchiectatic abscesses with heavy scar tissue walls are present. There is a diffuse fibrosis of the lobe and slight anthracosis. The lower lobe presents the same appearance as the upper lobe. The only living cells are polymorphonuclear leucocytes.

Following the spontaneous separation of both lobes, a minute bronchial fistula, several millimeters in diameter



Fig. 6 February 25 1933. Portable roentgenogram 14½ weeks after the left pneumonectomy and 6 days after the development of an acute pulmonary abscess in the right lung. The pneumonectomy defect has closed except for a small sinus which is not demonstrable by roentgenographic examination.

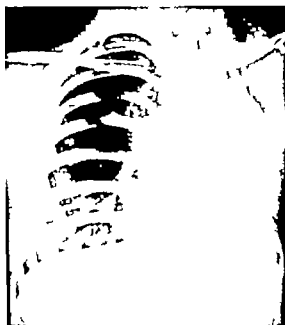


Fig. 7 May 31 1933. Roentgenogram 6½ months after the pneumonectomy and 3½ months after the development of a pulmonary abscess in the right lung. The abscess has cleared under non-surgical therapy. The pneumonectomy defect is completely obliterated.

could be seen in the region of the upper lobe hilum. A fistula from the lower lobe bronchus did not occur. The pleural space was packed daily with gauze, and the pleural defect (Fig. 5) decreased rapidly being aided by the previous thoracoplasty. Exercises and postural wedge compression (3) were started to correct the rather prominent right dorsal and lumbar scoliosis, which, although present before the pneumonectomy, was increased by the operation. The vital capacity 1 month after the pneumonectomy was 1,150 cubic centimeters, 45 per cent normal. There was no dyspnea. Six weeks after operation the patient was allowed to be up in a chair for 15 minutes daily. The bronchial fistula closed spontaneously 9½ weeks after operation, at which time the pleural defect had decreased to a small residual sinus. During the succeeding several weeks the patient was allowed to walk about the ward for 30 minute periods three times daily.

The patient continued to be wholly without sputum until February 10, 1933 (97 days after operation) when she complained of a "head cold." During the next several days purulent sputum appeared in increasing amounts. The previously normal temperature rose to 103 degrees F. Roentgenographic examination made 4 days after the onset of these symptoms revealed a pneumonic infiltration of the right lung with a localized area of abscess formation in the second intercostal space. A roentgenogram 3 days later demonstrated the abscess cavity more clearly (Fig. 6). The patient was not dyspneic, despite the presence of this abscess in the remaining lung. A few spirochetes were seen on examination of the sputum and accordingly an intensive course of neosarphenamine was started. The patient also received postural drainages and carbon dioxide inhalations at frequent intervals. The response to treatment was prompt. Eighteen days after the onset of symptoms, the sputum disappeared. The pneumonitis subsided rapidly but the abscess cavity decreased more slowly. The vital capacity 3 weeks after the onset of symptoms was 1,320

cubic centimeters, 51 per cent normal. Subsequent roentgenograms demonstrated a gradual improvement of the residual lesion in the right lung.

An electrocardiographic examination by Dr. F. D. Johnston 5 months after operation revealed a sinus arrhythmia with changes in the location of impulse formation, and inverted T waves in Lead I with small M shaped QRS complexes. The T wave changes in Lead I may be due to a shift in the position of the heart.

*Present condition:* At the time of submitting this report, 6½ months after the pneumonectomy and 3½ months after the development of the abscess in the right lung, roentgenographic examination shows a slight residual infiltration in the region of the pre-existing abscess but no abscess cavity can be seen (Fig. 7). The pneumonectomy defect is healed and the patient (Fig. 8) is without cough or sputum. The vital capacity has increased to 1,415 cubic centimeters, 55 per cent normal. To lessen the possibility of a recurrence of an abscess in the right lung, the patient has not as yet been allowed out of bed.

A review of the literature on experimental pneumonectomy discloses that, in 1881, Gluck first demonstrated that resection of an entire lung could be successfully performed in rabbits. In the following year Biondi (16) reported 30

<sup>1</sup>Since submitting this report, the patient's convalescence has been entirely satisfactory. She was discharged from the hospital on December 21, 1933 (15½ months after operation). At which time her condition was as follows: There had been an increase of 25 pounds (11½ kilograms) over her weight before the pneumonectomy. She was not dyspneic when walking, and she had no cough or expectoration. Roentgenographic and physical examinations revealed no evidence of residual abscess or pneumonitis in the right lung. The vital capacity had increased to 1,665 cubic centimeters (61 per cent normal). A letter written by the patient on December 1, 1933, stated that she was without symptoms.



Fig. 8. Photograph of patient 6½ months after total removal of the left lung. The anterior incision was employed for parasternal division of the costal cartilages prior to thoracoplasty. The pneumonectomy wound (upper posterior incision) is healed.

successful complete pneumonectomies in 57 animals. Since then numerous investigators have published reports which were mainly concerned with variations in operative technique. Their results show that the mortality in animals was chiefly due to postoperative pleural effusion and empyema, tension pneumothorax resulting from leakage from the bronchial stump and edema of the opposite lung. Quinby and Morse believed that the two main difficulties in attempting excision of the dog's lung were adequate closure of the bronchial stump so that it would not leak air and provision for the compensatory filling of the empty half of the chest by the remaining thoracic organs. Sauerbruch and Robinson were of the opinion that the experimental removal of one lung can be accomplished successfully only when the cavity persisting after the operation is diminished in size as soon as possible, in order thereby to avoid the accumulation of a transudate. Most of the experimental work has been concerned with removal of the normal or healthy lung and the conditions of the experiments were therefore not analogous to the removal of diseased lungs in humans. Schluter and Weidlein, using Willy Meyer's (18) inversion method of treating the bronchial stump, excised one entire lung in four animals. In two of the three surviving animals, a pulmonary abscess had been previously produced in the lung that was removed. The single death occurred from empyema in an animal in which a gross pleural infection, resulting from the previously established pulmonary abscess, was ob-

served at the time of operation. For a critical review of the literature concerning experimental pneumonectomy reference should be made to the comprehensive article by Schluter and Weidlein.

Willy Meyer (10) has emphasized that the experience gathered in experimental pulmonary surgery cannot be directly transferred to the treatment of pulmonary disease in man. Although the experimental removal of an entire lung was performed successfully in 1881 (Gluck) it was not until 50 years later that the first deliberately planned therapeutic removal of an entire human lung was successfully undertaken (Nissen, 1931).

#### SUCCESSFUL TOTAL PNEUMONECTOMY

From his observations on pulmonary lobectomy Nissen, in 1931, planned a technique which he successfully applied in removing an entire lung for bronchiectasis. This is the first successful instance of the complete removal of one lung for therapeutic purposes. A brief summary follows.

The patient, girl, 2 years of age, developed a severe mediastinal empyema following a crushing injury to the thorax. An immediate incision in the jugulum resulted in liberation of air through the incision. The simultaneous occurrence of a tension pneumothorax left no doubt, according to Nissen, that a tear in the left main bronchus was the cause of the symptoms. An empyema of the left pleura developed and drainage was instituted. During the course of several months the symptoms of a chronic pulmonary suppuration appeared. An abscess, which presented in the third (left) intercostal space near the sternum, was drained. The wound communicated with the left main bronchus. Lipiodol, injected through the fistula, demonstrated a bronchiectasis of the entire left lung. A bronchostoma

resulting from the injury to the main bronchus, was the obvious cause of the pulmonary suppuration. Although the patient's general condition was not good, it was decided to extirpate the entire left lung.

After paralyzing the left diaphragm, an extensive auxiliary resection of the third to fifth ribs was performed. The extensive adhesions, which were of a vell like consistency offered no difficulty in separation of the lung. After the pedicle of the lower lobe had been developed and while endeavoring to isolate the upper lobe, strong traction on the hilum resulted in temporary cardiac stoppage. The operation was discontinued and the entire wound was tamponaded with gauze. The second stage was performed 14 days later. The gauze packing was removed. Beginning peripherally the upper lobe was freed. A dense adhesion at the apex required division between ligatures. After the entire lung was separated, an elastic tube ligature was tied around the hilum proximal to the bronchial obstruction and additional silk ligatures were tied peripheral to the elastic ligature. Gauze was again packed around the lung. After operation the temperature was elevated to 39 degrees C., the pulse rate varied between 140 and 160. On the eighth day the fever and tachycardia decreased. The necrotic lung sloughed away on the fourteenth day. The residual cavity decreased rapidly in size, being aided by the extreme rise of the paralyzed diaphragm and the marked retraction of the mediastinum toward the side operated upon. Accordingly a thoracoplastic collapse of the thoracic wall was not necessary to obliterate the pleural space. After 8 weeks there was only a small sinistrous tract which led to the stump of the left main bronchus.

Mention should also be made of 2 earlier cases inasmuch as they have been cited in the literature as instances of complete pneumonectomy.

Sauerbruch's case reported in 1923 (12). In this case, accidental interference with the vascular supply of the left lung during the removal of a large posterior mediastinal tumor resulted in the subsequent necrosis and sloughing of the entire lung.

The patient, a girl of 19 years, was operated on in two stages. At the first stage, an exploratory thoracotomy with removal of the third to sixth ribs posteriorly was done. After the seventh and eighth ribs were resected at the second stage, a large ganglioneuroma of the posterior mediastinum was excised. A pleural exudate formed 3 weeks after operation. Four weeks later it became purulent and a rib resection was done to provide drainage. About 8 days later large pieces of necrotic tissue were removed from the pleural cavity with a forceps. They proved to be sequestra of necrotic pulmonary tissue, the largest measuring 13 by 8 by 4 centimeters. Later inspection of the pleural cavity is said to have revealed the absence of the entire left lung. There was no bronchial fistula. It was subsequently necessary to perform a thoracoplasty in several stages, in order to allow the thoracic wall to fall in and close the defect.

Macewen's case. The patient was operated on in 1895 but was reported in 1906. Although mentioned by Nilssen (11) and others (4) as being the first case of complete pneumonectomy, a careful review of the case history shows that Macewen drained at the first operation a huge tuberculous cavity which had resulted from an almost com-

plete destruction of the left lung. At several subsequent operations, he resected shreds of pulmonary tissue, but the adherent apex of the lung could not be removed. Obviously Macewen did not actually resect any large portion of the lung. In view of the fact that this case has been misquoted as one of complete pneumonectomy a detailed abstract of the operation is appended.

At the first operation, performed on April 24, 1895, a large tuberculous pulmonary cavity was drained. "One hundred sixty ounces of pus, along with sloughs of the lung and caseated debris, were removed."

By means of the finger and the long probe introduced into the cavity a dense layer of lung tissue with shreds of disintegrated lung was found still adherent to the chest wall.

After 4 weeks it was deemed advisable to perform thoracoplasty both with the view of thoroughly exploring the cavity and removing the shreds of lung tissue still remaining, and also with the hope of reducing the dimensions of the cavity.

Excision of portions of the fourth, fifth, sixth, and seventh ribs was performed. The view obtained was such as to enable one to see that there was no vestige of the left lung remaining, save shreds adhering to the walls of the chest, a portion at the apex and a stump representing the larger bronchi and the corresponding blood vessels, somewhat fused together and covered by granulation tissue.

There were several shreds of disintegrated lung tissue still adherent to the diaphragm to the outer walls of the chest, and to the apical part of the thorax. The former were removed, the latter cut short, their proximity to the large subclavian vessels rendering it undesirable to attempt complete removal.

Portions of the third, eighth, and ninth ribs were removed at a later date to further facilitate contraction.

After the interior had become aseptic and a layer of healthy granulation tissue had filled the various recesses, the skin was laid over the now thickened pericardium and diaphragm and stump of lung and soon became adherent and filled up the cavity a small sinus at the upper end persisted, coming from a point where shreds of the apical portion of lung remained. On several occasions, while the cavity of the thorax was still open, attempts were made to detach these, but on each the adhesions were found too firm to permit of easy separation. The adhesions of the apical portions to the subclavian vein precluded further detachment. "The loose portions were trimmed." The patient was examined 11 years after operation and he was found to be in good health. Since his operation he had not been ill, he had been regularly at work, and he had walked as much as ten miles without fatigue.

#### FATAL CASES OF TOTAL PNEUMONECTOMY

The reports of the recorded unsuccessful instances of total pneumonectomy are instructive in that they illustrate the technical difficulties and the operative and postoperative complications that may be encountered. Mention of the cases of Kuemmel (6, 7), Willy Meyer (10) (3 cases), Lilienthal (8) (2 cases) and Archibald (1) will be made. The causes of death and the technique of the operations will be considered in the hope that the experiences gained by these cases may serve as a guide to those who may undertake total pneumonectomy under varying conditions.



Kuennell's case (1911) is the first recorded instance of complete pneumonectomy in man.

A one stage procedure was employed for resection of the right lung involved in a diffuse carcinoma. The preoperative compression of the lung by a pleural effusion made it unnecessary to resort to differential pressure when the thorax was entered. After the pedicle was clamped, the entire lung was amputated. The clamp was left in place and the pedicle was not ligated. The cause of death in this case is uncertain. In his first report (6), Kuennell mentions the development of a bronchitis on the third day after operation. Improvement did not occur and the patient died on the sixth day with increasing pulmonary edema and tracheal rales. Postmortem examination showed the bronchus and pulmonary vessels tightly compressed with the clamp. The pulmonary stump was necrotic, and the pleural cavity and diaphragm were infiltrated with carcinomatous nodules. Fatty degeneration of the liver, a flabby heart, and a diffuse bronchitis were also found. In a subsequent report (7) Kuennell states that the patient died of sepsis arising from necrosis of the pulmonary stump.

An acute streptococcal septicæmia was the cause of death in a recent (1932) patient of Archibald's (1).

A three stage procedure was employed for the removal of a tumor of the left stem bronchus which had caused a bronchiectasis of the lower lobe. At the first stage, an exploratory thoracotomy revealed no metastases and a preliminary pneumothorax was induced in order to stiffen the mediastinum. At the second stage, the lower lobe was excised because of suppurative bronchiectasis which was caused by obstruction by the tumor. About a month later, the upper lobe, together with the stump of the lower lobe bronchus and the stem bronchus, from a point about 1 inch from the tracheal bifurcation, was removed through an anterior incision. The septicæmia that was responsible for the patient's death 4 days after the final operation was thought to have come from a very small empyemic cavity that followed the lower lobe lobectomy.

Archibald concludes from this experience that it would have been better to have removed the whole lung at one stage through an anterolateral incision and by the same technique as he employed for the final stage, provided the mediastinum had first been stabilized by an induced pneumothorax. Kuennell likewise recommended a preliminary induced pneumothorax. He believed that a pneumothorax, with or without an effusion, would decrease the danger of extirpation of the lung. His deductions were based on his previous experiences with induced pneumothorax as a preliminary measure to the intrathoracic removal of carcinoma of the esophagus.

Hæmorrhage from the pulmonary pedicle during the individual ligation of the bronchi and vessels resulted in death in one of Willy Meyer's (10) patients, operated on in 1915. While endeavoring to ligate the main trunk of the pulmonary artery during resection of a bronchiectatic left lung, a large hæmorrhage occurred as the

ligature was being passed around the artery and as a result, the patient died on the table.

In Lillenthal's (8) first case, 1919, a severe hæmorrhage occurred as a complication during the ligation of the pedicle but the hæmorrhage was not directly responsible for the fatality.

The right lung involved with an extensive bronchiectasis, was resected in one stage by the chain ligature method. During division of the pedicle, a sudden hæmorrhage occurred from a large vein. Although the opening in the vein was secured with clamps, it was necessary to leave the clamps in place, owing to the patient's desperate condition. Death occurred 6 hours after operation, apparently from oedema of the remaining lung.

Secondary hæmorrhage from the pedicle was the cause of death 13 days after operation in Lillenthal's (8) second case (patient operated on in 1920).

In this case the left lung was resected in two stages because of a post-tuberculosis suppurative pneumonitis. Tube drainage of the pleural cavity was employed between stages. At the second stage the pedicle was ligated with 6 or 7 transfusion (chain) sutures of strong twisted silk and the entire lung was immediately amputated.

Lillenthal believed that the hæmorrhage occurred from a destructive infection of the wall of an important vessel probably the pulmonary artery as the ligatures had already sloughed off at the time of the hæmorrhage.

Oedema of the contralateral lung was responsible for the death of one of Willy Meyer's (10) cases, a boy of 5½ years, operated on in 1920.

A resection of the right lung was done because of bronchiectasis and lymphosarcoma, the latter being discovered on examination of the specimen. After primary clamping of the hilum, the entire lung was amputated in one stage. Careful hæmostasis was obtained by surrounding the pedicle proximal to the clamps with a large, round needle and catgut in sections. In this case, airtight drainage of the pleural cavity was used.

Pneumonia of the lung operated upon, following a first stage operation, was responsible for the death of one of Willy Meyer's patients for whom he had planned a two stage removal of the left lung which was involved in a postpneumonic process.

The totally adherent lung was loosened with difficulty at the first stage, the collapsed lobes were surrounded with gauze, and the wound was closed. Airtight drainage of the pleural cavity was instituted. On the third day after operation, the patient developed difficulty of expectoration with signs of increasing inflammation, which was probably pneumonia, on the side operated upon and he succumbed on the following day. A partial necropsy revealed no evidence of aspiration by the opposite lung. In retrospect, Meyer believed that one stage procedure might have offered a better chance of recovery.

## CONSIDERATIONS OF OPERATIVE TECHNIQUE

In reviewing the cases of complete pneumonectomy mentioned, it can be seen that in 6 of the 7 unsuccessful cases, primary amputation of the lung was carried out. In the remaining case (Meyer), the patient died after separation of the lung at the first stage and before the contemplated removal of the lung at a second stage. In these 6 cases of primary amputation, the following complications were noted. A serious hemorrhage from the pedicle occurred during operation in 2 instances (Meyer, Lilenthal), one of which was fatal (Meyer). Infection of the pulmonary stump resulted in a secondary fatal hemorrhage from the pedicle in 1 case (Lilenthal) and it may have been the cause of death in another case, although a bronchitis on the contralateral side was also present (Kuennell). (Edema of the contralateral lung was the cause of death in 2 instances (Meyer, Lilenthal). In Archibald's case, septicæmia arising from an empyema pocket that followed the lower lobe lobectomy resulted in death 4 days after the removal of the remainder of the lung. Although a primary amputation of the lower lobe had been done the empyema was not necessarily dependent on the technique that was employed.

Primary amputation of the lung was not performed in the 2 successful instances of complete pneumonectomy (Nissen's and the writer's cases). In these 2 cases a mass ligation of the pedicle was used and the lung was allowed to slough. Sauerbruch's case should probably be included in this group, as the same result occurred although it was unintentional. It would seem that this method of mass ligation of the pedicle allowing the lung to become necrotic and sequesterate minimizes certain complications that have resulted from primary amputation of the lung i.e. primary or secondary hemorrhage from the pulmonary stump and infection of the stump. This view corresponds with the conclusions arrived at by Meyer (10) after his several unfortunate experiences with primary amputation of the lung and individual ligation of the vessels and bronchi. Meyer expressed the opinion that the pulmonary stump should be treated *en masse* inasmuch as he believed that separate ligation of the branches of the pulmonary artery and vein, with airtight closure of the infected and indurated stump was inadvisable or impossible. He did not mention whether immediate amputation of the lung should be done after mass ligation of the pedicle or whether the lung should be allowed to become necrotic and sequesterate. An exception to the use of mass ligation of the pedicle may occur in certain cases of bronchial malignancy in which a

greater length of the stem bronchus must be removed than is possible with mass ligation of the pulmonary hilum.

The location of the pedicle ligatures is a technical point that warrants consideration. The ligatures may be placed proximal to the bifurcation of the main stem bronchus, thus removing the entire lung as a unit, or the lobes may be ligated separately. Nissen employed the former method, inasmuch as there was a stenosis of the main bronchus. In the writer's case, despite the presence of a similar stenosis each lobe was ligated separately, although technically the ligatures could have been placed just as readily at the level of the main bronchus. In most cases of bronchogenic carcinoma, the more central position of the ligatures seems preferable. However, in bronchiectasis or multiple abscess, ligation of the individual lobes, provided they are readily separable seems advisable inasmuch as spontaneous bronchial closure is more likely to occur with several small fistule than with a single larger fistula. By placing the ligatures more distant from the mediastinum, the dangers of reflex cardiac disturbances and injury to the mediastinal structures may be lessened, and organization of the thrombi in the pulmonary vessels should be facilitated.

Although the choice between a one, two or more stage procedure may depend upon conditions presenting at the time of operation, it is of interest to note that all single stage procedures to date have been unsuccessful, whereas the successful operations of Nissen and the writer were performed in more than one stage. The probability of operative shock must certainly be greater with a one stage procedure which ordinarily requires a longer duration of anesthesia and more operative manipulation than does either stage of a two stage procedure. The obvious disadvantage of a two or more stage procedure is that the sputum continues after the first stage, thereby increasing the danger of aspiration pneumonia. In this regard, mention has been made of one of Meyer's cases in which death from pneumonia of the diseased lung occurred 4 days after the first stage of a contemplated two stage procedure.

Infection of the pleura should also be considered when choosing between a one stage and a two stage procedure. A one stage removal of a diseased lung exposes the virgin pleural cavity to a grave infection that may prove overwhelming. This danger may be lessened by applying the principles utilized by John Alexander in his two stage procedure for unilobar lobectomy. Alexander stresses preparation of the pleura at the

first stage by means of a sterile inflammatory exudate, induced by gentle stroking of the pleura with gauze, after the lung has been freed of any adhesions that might be present. This pleural exudate serves as a protective barrier against the inevitable infection that occurs within the pleural cavity after the second stage of the operation. It also aids in stabilizing the mediastinum, thereby reducing the dangers of mediastinal flutter and operative shock at the time of ligation of the pulmonary hilum. Alexander employs mass ligation of the pedicle, allowing the lobe to separate spontaneously.

After a review of the literature concerning experimental (14-39) and clinical total pneumonectomy and from experiences with one stage and two stage lobectomy I am of the opinion that the principles utilized by Alexander for unilobar lobectomy are applicable, with slight technical modifications, to the removal of an entire lung. By employing these principles, it would seem that the mortality of complete pneumonectomy should be materially reduced. It may be advisable however to modify this technique so that the lung after its separation, will not become adherent to the thoracic wall, mediastinum, and diaphragm. To accomplish this, the lung may be loosely surrounded with gauze or it may be enclosed in a rubber investment. For this purpose a suitable thin rubber bathing cap can be readily applied, the bathing cap being securely maintained in position by approximation of its free margins with a single suture above the pulmonary hilum and another suture below the hilum. Although I have not as yet employed this suggestion clinically I plan to do so if the opportunity presents.

Individual conditions and unforeseen operative developments will necessarily influence the technical procedure in each instance. These variations make it impossible to formulate a standard technique that can be routinely applied. However it would seem that the technique employed should be planned to anticipate the occurrence of certain complications that are almost inevitable, whereas it should endeavor to avoid other complications that may be preventable. The complications to be anticipated are pleural effusion, infection of the pleura, and opening of the bronchial stump. The complications to be avoided include operative shock, mediastinal flutter, mediastinitis, edema of the contralateral lung, primary and secondary hemorrhage from the pulmonary stump and infection of the stump. From the evidence presented, a two or more stage procedure appears to fulfill these requirements

more satisfactorily than a one stage procedure. In the application of a two or more stage procedure, the purpose of the first stage would be to obtain separation of the lung, in preparation for its subsequent ligation at the second stage. The use of continuous airtight drainage of the pleural cavity, instituted at the first stage and maintained until the wound is eventually packed wide open, should obviate the dangers of massive pleural effusion and tension pneumothorax.

#### PRE-OPERATIVE AND POSTOPERATIVE CONSIDERATIONS

*Pre-operative pneumothorax.* The use of an induced pneumothorax as a preliminary measure to pneumonectomy has been suggested by Kuemmel (7) and employed by Archibald. Although a pre-operative pneumothorax offers certain advantages, it can not be determined at this time whether it will prove of sufficient advantage to warrant its application as a routine measure. Perhaps its chief advantages are in obtaining a gradual pre-operative collapse of the lung and a stiffening of the mediastinum, both of which should aid in reducing operative shock during the pneumonectomy. An induced or at least, an attempted pneumothorax will also give an estimate of the probable extent of pleural adhesions. In cases of malignancy a pre-operative pneumothorax may be of value in determining the operability of the lesion in that subsequent roentgen examination may reveal evidence of metastases to the mediastinum, pleura, or diaphragm that would otherwise be invisible. In suppurative pulmonary disease, a satisfactory collapse of the lung should reduce the pre-operative amount of sputum and thereby lessen the incidence of aspiration pneumonia. In pulmonary suppuration, and especially pulmonary abscess, the possible occurrence of an empyema as a result of the pneumothorax is a danger that must be seriously considered and which may outweigh the advantages of pneumothorax in this group of cases. As an oleothorax provokes a greater degree of pleural reaction than a pneumothorax, the possibility of converting a pre-operative pneumothorax into an oleothorax suggests itself as a means of further stiffening the mediastinum. The pleural reaction may also be of value in preparing the pleura against later infection. However the advisability of an oleothorax as a pre-operative measure appears questionable at this time.

*Thoracoplasty.* Thoracoplastic measures may be necessary to provide for the obliteration of the pleural cavity after the pneumonectomy. In some instances, especially in children, thoraco-

plasty may not be needed. This was the case with Nissen's patient, a girl of 12 years. In Sauerbruch's patient, who was 19 years of age a subsequent thoracoplasty was required. If it should be found that a thoracoplasty is a necessary adjunct in adults, individual conditions would determine whether the thoracoplasty should precede or follow the pneumonectomy. A preliminary thoracoplasty offers certain advantages. Operative shock at the time of the pneumonectomy should be reduced as the preceding collapse of the lung will have resulted in a gradual shifting of the respiratory function and the pulmonary circulation to the contralateral lung. Furthermore, the thoracoplasty can be performed without contamination from the pneumonectomy wound. Hedblom has emphasized the fact that in bronchiectasis, the thoracoplasty in itself may be sufficient to relieve the symptoms. Because of this reason, a preliminary thoracoplasty was performed in the writer's case. A possible disadvantage of a preliminary thoracoplasty is that it may cause pleural adhesions that would make separation of the lung more difficult. An advantage of deferring the thoracoplasty until completion of the pneumonectomy is that closure of the thoracic defect can be observed, enabling one to determine whether a thoracoplasty will actually be necessary. A further advantage is that the thoracoplasty would be performed after a marked reduction or cessation of sputum thereby reducing the dangers of aspiration pneumonia.

**Scoliosis.** As a postoperative scoliosis is a complication that may develop after pneumonectomy prophylactic measures should be employed soon after operation. This is particularly important in children, in whom the scoliosis may otherwise be severe. A severe scoliosis is to be avoided as it may cause a further decrease in the respiratory function. Postural straightening of the spine and suitable corrective exercises should prove to be valuable measures in the prevention, as well as in the treatment of a scoliosis. The exercises should be planned to develop the muscles on the side of the convexity. Postural correction of the scoliosis can be obtained by having the patient lie on the side of the convexity, over a firmly rolled pillow placed slightly caudad to the apex of the curve (3).

#### SUMMARY

A case of resection of the entire left lung for bronchiectasis is reported.

The literature bearing on total removal of one lung in man is reviewed. The operative technique employed in the successful and unsuccessful cases is discussed, and the complications and

causes of death in the unsuccessful cases are enumerated. Variations in operative technique are critically considered.

**NOTE.**—The following recent cases of total removal of one lung have come to the writer's attention since the preparation of this article. These cases will be briefly mentioned in order to bring the literature on total pneumonectomy to date. The cases are listed in chronological order.

1. Reported by O. Ivanisevich and R. C. Ferrari. (La pneumectomie en el hombre, Bol. y trab. de la Soc. de Cir. de Buenos Aires, 1933 xvii, no. 13 July 5.) One stage removal of left lung for alveolar epithelioma of bronchus. The neoplasm was apparently a superior pulmonary sulcus tumor. Death occurred 8 days after operation. Operation, October 11, 1932.

2. Reported by E. Windsberg. (Personal communication, January 15, 1934.) Successful multiple stage removal of the right lung for bronchiectasis. This is apparently the second instance of successful total pneumonectomy in man. It is also the first successful case of total pneumonectomy in this country. Cautery pneumonectomy performed in two stages, was followed by resection of the lung in two stages. Operation, November 8, 1932.

3. Reported by H. Lilienthal. (Pneumonectomy for sarcoma of the lung in a tuberculous patient, J. Thoracic Surg. 1933, ii, 600-611.) One stage removal of left lung for sarcoma. Death occurred 4 days after operation. Operation, January 28, 1933.

4. Reported by E. A. Graham and J. J. Singer. (Successful removal of an entire lung for carcinoma of the bronchus, J. Am. M. Ass., 1933 cl, 1371-1374.) This is apparently the first case of successful removal of an entire lung for carcinoma of the bronchus. It is also the first successful instance of a one stage removal of the lung. Operation, April 5, 1933.

5. Reported by John Alexander. (Personal observation.) Case 1: Three stage removal of the right lung for multiple pulmonary abscesses, for which previous cauterization had been unsuccessful. Death occurred 8 days after operation. Operation, June 19, 1933.

6. Reported by E. Archibald. (Personal communication, November 2, 1933.) Successful one stage removal of the lung for sarcoma of the upper lobe and an infective bronchiectasis and pneumonitis in the lower lobe. The patient was reported as being well and the wound healed 3½ months after operation. Operation, July 7, 1933.

7. Reported by W. F. Rienhoff Jr. (Pneumonectomy. A preliminary report of the operative technique in 2 successful cases. Bull. Johns Hopkins Hosp., 1933 liii, 300-303, also personal communication, October 9, 1933.) Case 1: Successful one stage removal of the left lung for fibrosarcoma in a child 3½ years of age. Operation, July 24, 1933.

8. Reported by John Alexander. (Personal communication.) Case 2: Successful multiple stage removal of the left lung for bronchiectasis. Lower lobe lobectomy 1931. Partial resection of upper lobe, July 1933. Symptoms continued, necessitating removal of the remaining portion of the upper lobe. Operation, October 16, 1933.

9. Reported by W. F. Rienhoff Jr. (Bull. Johns Hopkins Hosp. 1933, liii, 300-303.) Case 2: Successful one stage removal of the left lung for tumor of the bronchus. Operation, November 3, 1933.

10. Reported by S. O. Freedlander. (Personal communication, January 15, 1934.) One stage pneumonectomy for carcinoma of the left main bronchus. Uneventful convalescence. Thoracoplasty 3 weeks later to close

residual cavity and fistula. Death from pulmonary oedema on following day. Operation, November 4, 1933.

11. Reported by John Alexander. (Personal observation.) Case 3. One stage resection of the left lung for carcinoma of the bronchus. Thoracoplasty removal of upper four ribs and exploratory thoracotomy 5 days earlier. Death from cardiac failure occurred 30 days after operation. Operation, November 6, 1933.

12. Reported by R. H. Overholt. (Personal communication, January 11, 1934.) Successful one stage removal of the right lung for carcinoma. Operation, November 13, 1933.

## BIBLIOGRAPHY

### CLINICAL

1. ARCHERD, F. D. Discussion, Churchill, F. D. The surgical treatment of carcinoma of the lung. J. Thoracic Surg., 1933, II, 303-306.
2. ALEXANDER, J. Total pulmonary lobectomy: a simple and effective two stage technique. Surg. Gynec. & Obst., 1933, LVI, 658-675.
3. BRIGGS, J. D. Postural wedge compression of the thorax. J. Thoracic Surg., 1933, III, 90-103.
4. GARRÉ, C., and QUINCKE, H. Lungenchirurgie, 2d ed., 57-158, Jena. Gustav Fischer, 1912.
5. HEDBLÖM, C. A. Pathogenesis, diagnosis and treatment of bronchiectasis. Surg. Gynec. & Obst., 1931, III, 406-417.
6. KUHNKE, H. Verhandl. d. deutsche Gesellsch. f. Chir., 9, 1, 21, 147-149.
7. Idem. Probleme Chirurgie d. l. Soc. Internat. d. Chir. Bruxelles, 91, 703.
8. LILIENTHAL, H. Resection of the lung for suppurative infections with a report based on 31 operative cases in which resection was done or intended. Ann. Surg., 1932, LXXV, 357-380.
9. MACLEOD, W. The Cavendish Lecture on Some points on the surgery of the lung. West Lond. M. J. 1906, XI, 163-183.
10. MEYER, W. Observations on lung suppuration and its treatment. Arch. Surg., 1923, VI, 361-425.
11. NIMICK, R. Excision eines ganzen Lungensegels. Zentralbl. f. Chir., 1911, LVIII, 3003-3006.
12. SAUERBRUCH, F. Die Nekrose einer Lungenhälfte nach Exstirpation eines Gangliomcarcins des Brustsympathicus und ihre allgemein pathologische Bedeutung. Menschen. med. Wchschr. 1923, LXV, 1011-1012.
13. STEWART, C. A. In MEYER, J. A. Vital Capacity of the Lungs, p. 116. Baltimore: The Williams and Wilkins Co. 1925.

### EXPERIMENTAL TOTAL PNEUMONECTOMY

14. ADAMS, W. E. and LIVERSTOCK, H. M. Lobectomy and pneumectomy in dogs, experimental surgery. Arch. Surg., 1932, LXXV, 803-808.
15. BERTMAN, R. B. Experimental closure of large bronchi: a study of the factors concerned in the failure of the bronchi to heal. Arch. Surg., 1924, LVIII, 418-432.
16. BUCCHI, D. Exstirpazione del polmone. Glor. Internaz. de. Med. Napoli, 1881, n. 8, IV 759; and 1881, V 248 and 417. Quoted by Murphy (20) and Tuffier (38).
17. Idem. Contributo alla Chirurgia Polmonare. Clin. chir. 1895, III, 435-459.
18. COURMONT, J. Sur la pneumonectomie expérimentale avec survie prolongée. Soc. de Biol., 1912, LXIII, 503-504.

19. CHEVAL, O. Contribution à l'étude de la pneumonectomie. Thèse Lyon, 1894. Quoted by Courmont.
20. FRIEDRICH, P. L. Ueber den Raumnachschub in der Brusthöhle nach einseitiger Lungentamponade, nebst Bemerkungen ueber das operative mediastinalemphyssem. Arch. f. klin. Chir., 1908, XCIV, 647-657.
21. GIERZ, K. H. Ueber Exstirpation von Lungen und Lungenlappen mit Versorgung des Bronchialstumpfes durch frei transplantierte Fascia lata. Zentralbl. f. Chir., 1914, XLII, 1433-1435.
22. GLOCK, T. Experimenteller Beitrag zur Frage der Lungentamponade. Berl. klin. Wchschr. 1881, XVIII, 645-648.
23. HEUTE, G. J., and DUNN, G. R. Experimental pneumectomy. Bull. Johns Hopkins Hosp., 1920, XXII, 31-42.
24. JOHNSON, M. Surgery of the lung: cure of the stump in pneumectomy and in lobectomy. Arch. Surg., 1928, LXII, 9-101.
25. KAWAMURA, K. Experimentelle Studien ueber die Lungentamponade. Deutsche Ztschr. f. Chir., 1914, CXXX, 189-222.
26. MACDONALD, T. L. Some studies in pulmonary surgery calculated to establish the feasibility of complete pneumonectomy in man. Tr. Am. Inst. Homeop., 1899, IV, 374-380.
27. MARCUS, S. Recherches relatives aux conséquences de l'extirpation expérimentale des poumons. Comp. rend. Soc. de Biol., 1881, III, 323.
28. MEYER, W. Pneumectomy with the aid of differential air pressure, an experimental study. J. Am. M. Ass., 1909, LIII, 1078-1087.
29. MURPHY, J. B. Surgery of the lung. J. Am. M. Ass., 1908, XLII, 341-350.
30. QUINCY, W. C., and MORAN, G. W. Experimental pneumectomy: the application of data so obtained to the surgery of the human thorax. Boston M. & S. J. 1911, CLXV, 121-124.
31. ROBINSON, S. Experimental surgery of the lung. I. Thirty animal operations under positive pressure. Ann. Surg., 1903, XLVII, 184-211.
32. ROBINSON, S., and SAUERBRUCH, F. Untersuchungen ueber die Lungentamponade unter verschiedenen Anwendung beider Formen des Druckdifferenzverfahrens. Deutsche Ztschr. f. Chir., 1909, CLV, 547-550.
33. SAUERBRUCH, F., and ROBINSON, S. Investigations concerning the technic of lung resection with the application of both forms of differential pressure. Ann. Surg., 1910, LI, 320-330.
34. SCHIEFFELMAIER, E. Thierexperimente zur Lungenchirurgie. Arch. f. klin. Chir., 1903, C, 985-1017.
35. SCHIEFFELMAIER, A. Experimentelle Untersuchungen ueber Lungenerkrankungen unter intrathorakaler Insufflation. Verhandl. d. deutsche Gesellsch. f. Chir., 1911, XL, 448-458.
36. SCHLICKER, S. A., and WEIDENFELD, I. F. Surgery of the lung: experimental lobectomy and pneumectomy. Arch. Surg., 1920, XLII, 439-450.
37. SCHWARTZ, A. Chirurgie du Thorax. pp. 289-292. Paris: Octave Doin et Fils, 912.
38. TUFFIER, T. Chirurgie du Poupon en particulier dans les Cavités Tuberculeuses et la Gangrène Pulmonaire. pp. 31-36. Paris: Masson et Cie., 1897. Also, Cong. Internat. d. sc. méd. & Moscou 1897 Sect. Chir., 5-63.
39. VOITTE, E. Contribution à l'étude de la pneumonectomie. Thèse Lyon, 1908 p., Lyon: Walmer et Cie. 1903.

## DIAGNOSIS AND TREATMENT OF PHARYNGO-ŒSOPHAGEAL DIVERTICULUM

HERMAN J. MOERSCH, M.D., ROCHESTER, MINNESOTA  
Division of Medicine, The Mayo ClinicE. STARR JUDD, M.D., F.A.C.S., ROCHESTER, MINNESOTA  
Division of Surgery, The Mayo Clinic

**R**OKITANSKY, in 1840, divided diverticula into traction and pulsion types. Pulsion diverticula are characterized by a pushing out of the mucosa from the lumen through the muscular coat traction diverticula by a dragging out of the wall by adhesions of adjacent glands or from structures to the outer side of the wall. Pharyngo-œsophageal diverticula belong to the former type. Ludlow, in 1746, was first to observe and describe such a case. It was assumed that these diverticula originated between the pharyngo-œsophageal juncture, hence the term pharyngo-œsophageal diverticulum Killian and Keith, however, have demonstrated that they originate between two definite parts of the inferior constrictor muscle. They arise on the posterior wall of the pharynx in the median line at the level of the cricoid cartilage and just above the pharyngo-œsophageal juncture. At this site, weakness is manifest in the muscular wall below the last transverse fibers of the constrictor pharyngis inferior muscle and those lower circular or oblique fibers of the constrictor pharyngis inferior muscle that go to make up the cricopharyngeus muscle. Consequently the term pharyngeal pulsion diverticulum would seem the more appropriate.

The pharynx, however, gives rise to two other types of diverticula from which the pulsion diverticulum must be distinguished. The first is of congenital origin, and usually is termed pharyngeal diverticulum. It arises from the bronchial clefts, in most cases the opening of the sac is in the vicinity of the base of the tonsil or pyriform sinus. Another type of diverticulum has been described by Moynihan; it arises between a gap immediately below the border of the cricopharyngeus muscle and the fibers of the œsophagus which are descending from their origin at the back of the cricoid cartilage. These have been called lateral diverticula. A few reports of such cases have appeared in the literature, the treatment is the same as that accorded true pulsion or pharyngo-œsophageal diverticula.

Two hundred seventy-six patients with pharyngo-œsophageal diverticula were observed at The Mayo Clinic previous to February, 1933. The condition was found to occur much more

commonly among men (227) than among women (49) a ratio of 4.5 + 1. It becomes manifest in later life. The average age of the 276 patients was 57.2 years, the youngest patient was aged 31 years, and the oldest 83. Most of them, however, were aged between 50 and 70 years. It was difficult to determine accurately the duration of symptoms, because many patients had become so accustomed to a certain degree of dysphagia that they regarded the condition as normal for them, and only after removal of the sac did they realize the degree of the disability from which they had suffered. The average duration of pre-operative symptoms was 6.1 years.

## ETIOLOGY

The etiological factors are somewhat obscure. A history of trauma, adenomatous goiter, and stricture of the œsophagus may be occasionally elicited, but these factors seem to be a casual rather than a true underlying cause. The usual description found in textbooks is that, during swallowing, considerable pressure is exerted on the wall of the œsophagus and pharynx, and the inner coat naturally might be forced through the weakened area between the transverse and oblique fibers of the inferior constrictor muscle. However Waggett and Davis by the use of water pressure, were unable to find a greater tendency to herniation at this point than in the remainder of the œsophagus. Barclay recently has presented observations to refute the ordinary conception of deglutition and he feels that the creation of negative pressure is of greater importance than the positive pressure in deglutition. Considerable further proof is, however necessary to substantiate this contention.

Bell, in 1813 first suggested that the origin might be the result of a spasmodic structure of the musculature in the lower part of the pharynx which caused fasciculations of the muscular layer above the obstruction and hernial protrusion of the mucosa. Jackson more recently emphasized the importance of the cricopharyngeal muscle in the development of pulsion diverticula, and feels it is due to the inco-ordination of the cricopharyngeal pinchcock resulting in failure to open the

upper end of the oesophagus closed by tonic contractions.

The possibility of an embryologic or developmental anomaly as the basis of pulsion diverticula has been mentioned by C. H. Mayo we are inclined to consider such origin possible since several of our patients with pharyngo-oesophageal diverticula had complained of difficulty in swallowing from early childhood. Jackson has reported similar experience. Unfortunately, no definite roentgenological evidence is available to substantiate such an hypothesis, primarily because sufficient evidence has not been elicited to warrant roentgenological examination. One of us (Judd) has noted that dimpling ordinarily appears in the mucosa at the point where pulsion diverticulum occurs. It is conceivable that such dimpling in these cases is more marked and assumes the form of a very small pouch, thus providing the proper anlage for development of the diverticulum. It is assumed that incoordination of the cricopharyngeus muscle increased intrapharyngeal pressure, decreased elasticity of the tissues with increasing age, and the constant accumulation of material in the pouch would facilitate its development. However these factors, in the absence of such a developmental anlage, would probably fail to produce pulsion diverticulum. Evidence in support of this hypothesis is presented by a case reported by Rush and Stingley of a large congenital diverticulum which was found to be present at birth and which arose from the posterior lateral wall of the oesophagus at the level of the cricoid cartilage.

The sac of a pharyngo-oesophageal diverticulum is composed primarily of the coats of the mucosa and submucosa, and, as has been mentioned, is due to the herniation of these layers through the muscular wall (Fig. 1). Muscle fibers do not compose an integral part of the sac, as is seen in traction diverticula. They may however project a short distance on to the neck of the pouch only rarely are strands of muscle found extending across its surface. The caliber of the neck of the sac usually remains small and tends to invade the superior mediastinum. It seldom projects below the arch of the aorta. Owing to the anatomical relationship of the oesophagus to the cervical portion of the spine the diverticulum tends to appear on the left side of the neck, although occasionally it may appear on the right side determining the situation aids in the selection of the site of exposure for removal of the sac, as it is best removed on the side of the neck toward which the diverticulum inclines.

## SYMPTOMS

The symptoms produced by pharyngo-oesophageal diverticulum are characteristic, and consist primarily of dysphagia, regurgitation, and the production of a typical gurgling noise on eating, speaking or on pressure over the sac when it is distended with air or food. The onset is usually insidious and consists of a dry scratchy feeling in the back of the throat and a tendency to the accumulation of mucus. Granular foods are especially difficult to swallow. The degree of dysphagia tends to increase with the size of the sac and may progress to complete obstruction which may terminate fatally. Small diverticula, however are occasionally encountered which may give rise to more difficulty than those of considerable size. Solid food generally causes more difficulty than liquid although considerable variations may be displayed. The dysphagia has been thought to result from the pressure of a distended diverticulum on the posterior wall of the oesophagus. Other factors, however are of far greater importance. Labey has emphasized that in the beginning the diverticulum is on the lateral wall of the oesophagus and remains in this position as long as it is of small size. When, however, the sac increases in size so that considerable food lodges in it, the traction and weight of the food in the sac so pulls on the neck of the sac that the opening of the diverticulum gradually changes from a lateral to a transverse position, the true opening into the lower portion of the oesophagus below the neck of the diverticulum assumes such a lateral position that it becomes difficult if not impossible for food to enter it. Jackson also pointed out that the action of the cricopharyngeus muscle adds to the degree of dysphagia, and Halstead stated that by its action the lower border of the neck of the sac forms a valve that may project into the lumen of the oesophagus and close it when the sac is full. Figure 2 demonstrates that the twisting which occurs with the change of position of the sac from medial to lateral might tend to increase dysphagia. The influence of the mechanical factors mentioned can be readily demonstrated at operation, since simple elevation of the base of the sac completely relieves dysphagia. However should too great traction be exerted obstruction again occurs.

Regurgitation is prone to occur when the sac has become large enough to retain liquids and food and it also tends to become more marked with increase in the size of the sac. It is particularly likely to manifest itself with the patient in the prone position, which produces strangulation and cough. This constitutes a definite risk,



Fig. 1. Mucous membrane herniating through muscular coat and forming diverticulum.

for material regurgitated during sleep may be aspirated into the lungs and give rise to pulmonary suppuration. Because of the cough the patient may be treated erroneously over a long period for tuberculosis or pulmonary suppuration before the true nature of the disease is discovered.

A peculiar clicking or crackling sound while the patient is speaking or eating is characteristic of the condition and is usually present. It can be produced in practically all cases by having the patients swallow and then make quick pressure over the sac. The sound is produced by the sudden expulsion of air from the diverticulum into a resonant chamber. This sound may become very annoying and with regurgitation causes patient to avoid eating in company or public places.

Large pharyngo-oesophageal diverticula may produce swelling with a sensation of pressure at the base of the neck, particularly on the left side with swallowing. It also produces hoarseness due to pressure on the recurrent laryngeal nerve. Loss of weight varies with the degree of dysphagia and the duration of symptoms. When the obstruction is marked loss of weight may be considerable.

#### DIAGNOSIS

Although the diagnosis of pharyngo-oesophageal diverticulum can usually be readily made from the clinical history further confirmatory evidence is essential. This can be obtained by roentgenological examination, passage of sounds according to the method of Plummer, and oesophagoscopy. The roentgenological examination will reveal the presence of the sac. It is necessary however to keep in mind the possibility of such lesions as a carcinoma high in the oesophagus



Fig. 2. Change in position of sac from mesial to lateral caused by twisting.

or stricture with obstruction and dilatation above the obstruction, which may closely simulate diverticula. Although the mucous membrane of a diverticulum seldom undergoes carcinomatous change it was found in one of our cases, and the possibility of such change must always be considered. Attention has been called to the necessity of ruling out before operation is undertaken any other oesophageal lesion that might be present, such as cardiospasm which we found in 4 cases. Crile and Dinsmore reported the case of a patient with carcinoma and cardiospasm, associated with pharyngo-oesophageal diverticulum. In practically all cases additional information is readily obtainable without risk by the passage of sounds as advocated by H. S. Plummer and Vinson. Should further information seem advisable, oesophagoscopy should be performed.





Fig. 3 Method used for passage of stomach tube.

#### TREATMENT

The treatment of pharyngo-oesophageal diverticulum is primarily surgical. In certain cases, however, palliative measures seem indicated, particularly if patients are advanced in years and if the sac is small and producing few if any symptoms. Palliative measures must also be resorted to when the patient is in such poor condition that immediate operation is inadvisable.

The periodic passage of sounds, a thread always being used as a guide, frequently affords considerable relief. This is done for the purpose of stretching the opening into the oesophagus and overcoming any existing spasm of the cricopharyngeus muscle. Lahey especially recommended this procedure as a postoperative measure to prevent recurrence of the diverticulum. It is particularly valuable if there is a tendency for spasm of the oesophageal introitus following operation.

If patients are being treated by palliative measures, they should be instructed to evacuate the pouch thoroughly after meals and at night before retiring. This tends to keep the sac clean and overcomes the risk of aspiration into the lung.

To avoid increase in risk, palliative procedures should be carried out in cases of marked oesophageal obstruction, dehydration, and malnutrition before operation is undertaken. Gastrostomy is

advocated but should be avoided if possible because of the high mortality of this normally simple operation on patients markedly dehydrated, or those advanced in years. The procedure which we have found most satisfactory and have described is the passage of a Sawyer tube over a previously swallowed silk thread as a guide (8). It is surprising with what ease a patient with marked obstruction is able to swallow a thread. In many cases, however, the physician is called on to exercise considerable patience before this feat is accomplished. Certain patients are better able to start the thread with the sac of the diverticulum filled with fluid; others are more successful when it is empty. Patients are able to swallow the thread in from 1 to 2 days, during which time they should receive fluids and nourishment intravenously and by proctoclysis. We have observed only 2 patients who were unable to swallow the thread. When the thread is safely anchored, a Sawyer type of tube can be slipped readily into the stomach. The use of a whalebone staff with a special guide (Fig. 3) facilitates the passage of the tube, as snubbing at the introitus may prevent the flexible catheter getting beyond this point. The tube can be left in place or removed after each feeding. Such procedure soon brings the patient into a condition suitable for operation. Imperatori has suggested the ingenious method of inversion of the sac by grasping its bottom, inverting it into the pharynx, and ligating the base, permitting it to slough off. Although the diverticulum usually lies loosely in the tissues of the neck, it may be surrounded by a dense fibrous wall (Fig. 2) so that the risk of attempting invagination is readily apparent. Division of the common wall between the diverticulum and the oesophagus has also been suggested, but the procedure carries considerable risk.

We usually carry out the operation in two stages, both of which are done under local anesthesia. The first stage consists of freeing the diverticular sac by dissecting it from the surrounding tissues in the neck and mediastinum. Then, after it has been completely separated from the surrounding structures, it is left prolapsed to the outside of the neck. The sac is sutured in this position by the use of a few stitches to attach it to the sternomastoid muscle and other muscles of the neck. The cavity from which the diverticular sac was removed is left without drainage. The second stage is done 8 days after the first. At this time the sac is loosened from the surrounding tissues by blunt dissection carried on down to the oesophagus. After this is completed, the sac is clamped off and is removed and the

neck of the sac is sutured over. In the event the diverticular sac is large, it is much safer to do the operation in two stages. This causes the patient very little additional inconvenience.

The recent trend has been to do the operation in one stage if the sac is small. With this plan the sac is removed at the first operation. Apparently this can be carried out safely provided it is not necessary to continue the dissection down into the mediastinum.

Whenever it is advisable to remove a small diverticular sac in two stages two silk sutures are passed through the outer wall of the fundus of the sac and are brought to the outside and allowed to project through the wound to facilitate finding the sac at the time of the second stage of the operation. These sutures do not pass through the mucosa of the sac and are not tied down into the tissues. It seems best not to fix the sac to any of the tissues for the reason that the effort of swallowing or muscular pull from coughing is likely to cause the sac to break at the point of fixation.

On a few occasions following removal of the œsophageal diverticulum, there has been a slight tendency toward constriction of the œsophagus. However, this is not a frequent experience and we do not pass a sound after the operation unless it is evident that there is some constriction.

Some of our patients have had fistula from the œsophagus for a while. In no instance has it been necessary to institute surgical treatment to obtain closure of the fistula although on a few occasions the fistula has persisted for a considerable period. Passing sounds into the œsophagus has seemed to hasten the healing of these fistulas.

The most serious risk is encountered in dealing with the elderly patient who has other difficulties in addition to the condition in the œsophagus, and who nevertheless must have the diverticulum removed because of increasing interference with swallowing. Were it not for this group of elderly patients there would be no occasion for serious trouble following removal of the œsophageal diverticulum.

One hundred seventy-seven of the 276 patients under our observation were operated on. That the surgical treatment is not without a certain element of risk is shown by the fact that among the 99 patients not operated on there were 3 who died before examination or operation could be instituted. One patient died from spontaneous perforation of the diverticulum into the mediastinum with bleeding. Death occurred apparently within the space of a few minutes. A second patient died from apoplexy and a third from

starvation. That a certain degree of risk must be anticipated, no matter what type of surgical procedure is used, is apparent from the ages of the patients treated, their poor general condition and the frequency of associated pulmonary infection. This is illustrated by the two postoperative deaths from coronary infarct while the operative field was in excellent condition, but still these deaths must be charged to the surgical procedure. The comparative safety of surgical extirpation of the sac is illustrated by the fact that we have been able to operate on 57 consecutive patients without a death, and on another series of 41 without untoward results.

# BIBLIOGRAPHY

1. BARCLAY, A. E. The normal mechanism of swallowing. *Proc. Staff Meet. Mayo Clin.* 1930, v 351-357.
2. BELL, CHARLES. Surgical observations. London Longman and others, 1816 i 64.
3. CRILE, G. W. and DIMORE, ROBERT. Diverticula of the œsophagus. *Surg. Clin. N. Amer.*, 1924, iv 863-869.
4. HALSTEAD, A. E. Diverticula of œsophagus. *Surg. Clin. Chicago* 1919 iii, 667.
5. IMPERATORI, C. J. Endoscopic treatment of pulsion diverticulum: a further report. *Arch. Otol.* 1929, ix 266-270.
6. JACKSON, C., and SHALLOW, T. Diverticula of œsophagus, pulsion traction, malignant and congenital. *Ann. Surg.* 1926 lxxviii, 1-19.
7. JUDD, E. S. Œsophageal diverticula. *Arch. Surg.*, 1920, i, 38-52.
8. JUDD, E. S., and MOERSCH, H. J. Pharyngo-œsophageal diverticulum. *Surg. Clin. N. America*, 1929, ix, 793-800.
9. KEITE, ARTHUR. A demonstration on diverticula of the alimentary tract of congenital or of obscure origin. *Brit. M. J.* 1910, i, 376-380.
10. KILLIAN, G. La bourse de l'œsophage. *Ann. d. mal. de l'oreille, du larynx*, 1908, xxxiv 1-53.
11. LARLEY, F. H. Successful operation in eight cases of pulsion diverticula of œsophagus. *Boston M. & S. J.* 1927 cxvii, 341-350.
12. LUDLOW. Quoted by Moynihan.
13. MAYO, C. H. Treatment of diverticulum of the œsophagus. *Tr. South. Surg. Ass.* 1922 xxxv 168-175.
14. MOYNIHAN, B. Diverticula of the alimentary canal. *Lancet*, 1927 i 1061-1066.
15. PLYMOR, H. S. The value of a silk thread as a guide in œsophageal technique. *Surg. Gynec. & Obst.* 1910 x, 510-523.
16. ROKITSANSKY, KARL. A manual of pathological anatomy. London Sydenham Society 1849 ii 8.
17. RUSH, L. V. and STINGLY, C. R. Congenital diverticulum of œsophagus case report. *South. M. J.*, 1929, xii, 546-548.
18. VIKSOV, P. P. Practical points in the management of pharyngo-œsophageal diverticula. *Colorado Med.*, 1924, xii, 6-7.
19. WAGGETT, L. B. and DAVIS, E. D. A case of pharyngeal diverticulum. *Lancet*, 1913 i 786-788.
20. ZIEGLER, F. A. and ZIEGLER, H. Krankheiten des œsophagus. In *Ziemssen's Handbuch der speziellen Pathologie und Therapie*. Leipzig, 1874, vii, 1 208.

## CONSERVATIVE TREATMENT OF ACUTE DUODENAL FISTULA

ALBERT E. McEVERS, M.D. F.A.C.S., ROCK ISLAND, ILLINOIS

WITHIN the last decade, there has been established a very definite and satisfactory management for the clinician who is called upon to treat acute duodenal fistula. It is the purpose of this paper to summarize the treatment and offer some additional suggestions.

McGuire in 1920 reported doing a jejunostomy of the Witzel type and feeding the patient by the introduction of food at a point below the fistulous opening. He did not claim the procedure to be original, but stated that he was unable to find reference to it in the literature. Erdman, in 1921, advocated jejunostomy feeding, and suction. Cameron, in 1923, and Lahry, in 1924, reported the treatment of duodenal fistula by suction. Potter's article published in 1927 described a method of destroying the potency of the intestinal juice by neutralizing its alkalinity and taking care of the excess by supplying a protein and fat combination in sufficient amounts to use up the juice before it could attack the tissues of the abdominal wall. Haden and Orr's experiments demonstrated the body needs for fluids, chlorides, and dextrose. The work of Walters and Bollman called attention to the changes in the blood resulting from duodenal fistula and the toxemia of duodenal fistula. Other authors have added to the management by suggesting modifications of technique and naming several types of buffer solutions.

## REPORTED MORTALITY

Colp in 1923, reported a series of 61 cases of duodenal fistula, the gross mortality being 61 per cent. Of these cases 36 were treated conservatively with a mortality of 60 per cent. He stated that gastro-enterostomy with pyloric occlusion gave a mortality of 85 per cent. The largest series of duodenocutaneous fistula was reported by Bohrer and Millie in 1931. They included 61 cases reported by Colp in 1923 and 44 cases collected by themselves—105 cases in all. They gave a combined mortality of 37 per cent of all the cases reported.

Kittelson in a recent review reported a series of 94 cases from the literature, and 3 of his own. Of this series, it was shown that 65 cases were treated conservatively with a mortality of 27.7 per cent. 30 cases were treated by surgery with a mortality of 50 per cent. The mortality of all groups, including all types of treatment, was 35.8 per cent.

The mortality of cutaneous duodenal fistula and the rapidity of its ravaging destruction is well known. The toxemia results from loss of acid and chlorine in the gastric and pancreatic juice discharged from the fistula. Resulting chemical changes in the blood are an increase in alkalosis, decreased concentration of chlorides in the blood serum, and a progressive rise of blood urea. This toxemia, with fluid loss and inanition, may speedily cause death if corrective measures are not properly instituted. These systemic effects, with the additional local results that are produced by the proteolytic action of trypsin in the pancreatic juice with its extensive erosion and excoriation, render this condition an emergency where prompt and correct management is essential.

Concerning the mortality rate of 27.7 per cent in the 65 cases treated conservatively (reported by Kittelson) it is hoped that this will be considerably reduced by added clinical experience and our improved knowledge. It is shown in the table that the etiological factor was as follows:

	Cases
Following operation on the gall bladder	30
Following operation for perforated duodenal ulcer	22
Following operation for nephrectomy	8
After resection of stomach from malignancy	8
After operation for acute appendicitis with obstruction	7
After rupture of the duodenum	6
From other causes	7

In the 22 cases following operation for perforated ulcer the 6 cases after rupture of the duodenum, the 8 cases following resection of the stomach from malignancy, 7 cases after operation for acute appendicitis with obstruction, a total of 43 cases, one could have well included a jejunostomy with the primary operation. It was definitely indicated in the 22 cases following operation for perforated duodenal ulcer.

A well functioning jejunostomy done at the time of the primary operation, becomes invaluable should duodenal fistula become a surgical complication. Duodenal fistula generally develops from the fourth to the ninth day after operation.

## TREATMENT

*Surgical.* Extensive surgical procedures are contraindicated for the treatment of duodenal fistula, because of the high mortality rate following. Jejunostomy however can be done with a num-

imum risk and can immediately be used for the introduction of food and chemicals into the lower bowel. It should be made with a valve-like control (the Witzel or Kader methods) which can be done without danger of leakage into the peritoneum. Potter has called attention to the fact that a simple jejunostomy made with a pursestring suture has in itself created most irritating duodenal fistulas.

*Medical.* The objectives of medical treatment are

1. Chemical nutritional and fluid loss replacement.
2. Nutritional maintenance.
3. The buffer action of food and solutions to render the proteolytic action of the trypsin innocuous to the fistulous tract and skin.
4. Protection of the skin by applications to prevent erosion.
5. Strapping of the discharging sinus to lessen the loss of duodenal secretion.

The fact has been established by experimental work and clinical results, that the chemical and fluid loss can be replaced and maintained. Sustaining nourishment can be administered by the subcutaneous and intravenous administration of salt solution and glucose. Additional nutrition may be given in sufficient amounts by feeding through the duodenal or jejunostomy tube. The Levine duodenal tube is useful if it can be passed beyond the fistulous opening of the duodenum or it may be used in the event that the jejunostomy does not function well.

The corrosive action of the duodenal secretion is chiefly due to the pancreatic component. Erdman recommended the dilution of this secretion with large amounts of water by mouth, and diluting the sinus secretion and flushing of the fistula. Potter acidulated the secretion in the sinus with tenth-normal hydrochloric acid solution and applied a preparation of beef to the skin, soaking gauze with it and applying it to surround the fistulous opening. The crater left in the center of this gauze dressing was filled with one to three drams of tenth normal hydrochloric acid solution. The outside of the gauze was made adherent to the skin with liquid adhesive or gutta serena was laid to the skin through the application of chloroform; thus he kept the beef juice and acid confined to the area to which it was to be used. The idea was to have the pancreatic juice digest the beef juice also to inactivate the pancreatic juice by action of acid upon it, based on the fact that trypsin functioned better in an alkaline media.

Howell has shown that trypsin is capable of digesting the tissues of the abdominal wall when

the fistulous discharge is acid. He also noted that the closer the fistula is to the pylorus the greater the tendency to be acid. Clinical observation of this fact is mentioned in the literature (Salmon and Gambill).

*Suction.* Suction could be used to advantage to carry away the secretion if it were not for the difficulty of its application. It is not necessary, provided the dressings can be changed frequently. Zinc oxide ointment or kaolin powder applied thickly protects the skin from the secretion that has previously had contact with the buffer solution.

*Open treatment and exposure to light.* The wound may be left open 2 to 4 hours twice a day and the whole abdomen exposed to the rays and heat from a 750 watt carbon bulb with a large reflector bowl. The actinic rays and heat are healing to the macerated skin. Secretions from the wound can flow away to the side, into fluffed dressings. The digestive action of the trypsin is greater when it is in contact with the skin on secretion-soaked dressings.

*Drainage.* Cushing has shown that the normal stomach can be bacteria free if sterile food is fed for 24 hours. Infection high up in the gastrointestinal tract is practically absent however, following perforated duodenal ulcer, infectious peritonitis may often result. These facts are important in the consideration of drainage to be used, following operation for perforated duodenal ulcer.

Penrose tube drain without gauze, applied through a stab wound in the right flank, into the peritoneal cavity and placed so as not to be near the line of suture in the repaired duodenum may be advantageous. The stab wound will serve admirably for drainage in the event that fistula does occur (Fig. 1). The opinion gathered from the literature indicates that drainage should not be used.

*Buffer solutions.* Erdman in 1921 used milk powder, glucose, and olive oil mixed with the entire secretion from the fistula for two-hourly eight-ounce jejunal feedings. Potter mentioned using boiled milk. He stated that in addition to its constipating effect, it supplied intra intestinal protein for the digestive action of pancreatic juice and tended to cut down the excess. From 4 to 6 ounces of boiled skimmed milk were given by mouth every 4 hours. However, Potter stated "The keynote of the treatment is the local application of tenth normal hydrochloric acid and sterile beef juice. Kittelson used whole milk thickened by the use of acidophilus placed locally in the wound and fistula, with tenth-normal hy

TABLE I

Composition dry		Composition of normal dilution	
	Per cent		Per cent
Fat	27.0	Fat	3.57
Protein	16.0	Protein	3.0
Lactose	8.7	Carbohydrate	6.54
Maltose	17.4	Salts	0.41
Dextrins	16.3	pH	7.3
Salts	3.3	Measurements and food values	
Moisture	1.4	ounce = 15 calories	
To prepare normal dilution	1 oz in 7 oz water	4 packed level tbsp. = 1 oz fluid normal dilution = 9 calories	

drochloric acid applied by means of a catheter. The milk solution was prepared by taking whole milk repasteurized then cultured with acidophilus, and kept warm for 6 hours.

In the case I am reporting as in others, ingested material soon appeared in the fistulous discharge. This fact inspired an attempt to buffer the tryptic action of the secretion before its exit from the duodenum. Reliquefied reolac was selected as a buffer agent for clinical trial because of the simplicity of preparation. Boiled milk, acidophilus milk, or any relquefied milk concentrate could be used with the same result. Table I shows the composition of reolac dry and the composition of the relquefied normal dilution as compared to breast milk and cow's milk, shown in Table III.

**How to prepare.** The amount of previously boiled water needed is warmed to about blood heat the prescribed number of level tablespoonfuls of reolac are put on top of the water and beat with an egg beater or table fork until dissolved. The utensils used in the preparation are previously sterilized.

If powdered protein milk were used, it could be boiled when relquefied, to render it sterile. The normal dilution gives the following formula (Table II) it has a high protein content which is desirable. Fats or oils could be added to increase its fat content.

#### Method of reolac administration

1 Six ounces are given by mouth every 2 hours for eight times in 24 hours, a total of 48 ounces, with food value of 912 calories. At first, most of the feedings given are returned through the fistulous opening.

2 Eight ounces are given every 2 hours for eight times by the jejunostomy tube, a total of 64 ounces in 24 hours, with a caloric value of 1216 calories.

**Note.** The mouth and tongue were thoroughly cleaned twice a day and an antiseptic mouth wash was used before every feeding.

TABLE II—COMPOSITION OF NORMAL DILUTION

	Per cent
Protein	3.25
Lactose	2.00
Butter fat	2.80
Salts	.50
Lactic acid	.15
Water	91.80
Hydrogen ion concentration pH 4.80	
1 fluid ounce = 12 calories	

TABLE III

Breast milk		Cow's milk	
	Per cent		Per cent
Fat	3.5—4	3.5—4	
Protein	1.5—2	3.3—3.5	
Lactose (sugar)	6—7	4.6—4.8	
Salts	0.2—0.25	0.65—0.75	

#### CASE REPORT

A. E. F. a male of 39 years, admitted to the hospital July 15, 1933. He reported good health except recurrent attacks of dyspepsia with food and soda relief for the past 4 or 5 years. Present attack occurred suddenly at 3 a.m. while asleep. Pain was severe. His family physician was called and a diagnosis of perforated peptic ulcer was made. Family history was irrelevant. He arrived at the hospital in shock. Intravenous infusion of 1000 cubic centimeters of 0.9 per cent glucose in salt solution was administered. He was operated on shortly after being admitted.

Under ethylene anesthesia the peritoneal cavity was opened. A perforation 5 centimeter was found in the anterior wall of the duodenum. The opening in the duodenum was closed with Paget-Steecher's linen and the wound covered with piece of omentum. A jejunostomy of the Witte type was done, and stab wound made in the upper right quadrant, in which two drains of Penrose tubing were inserted. Postoperative diagnosis was perforated duodenal ulcer postoperative condition was good.

Continuous hypodermoclysis was started when the patient was returned to bed. 1000 cubic centimeters of 10 per cent glucose in salt solution was given intravenously. First, second, and third days after operation were uneventful; the fourth day the duodenal fistula developed. At first, there was a slight discharge noted on the dressings which appeared to be duodenal secretion. The amount of this discharge gradually increased on the fifth, sixth, seventh, and eighth days after operation. Only slight tryptic action was manifested up to this time. On the ninth day the duodenal drainage became enormous. It appeared that the entire duodenal contents were discharged through the stoma. The skin became inflamed, eroded, and macerated. Most of the drainage came through the stab wound in the right flank. Discharge also came through the upper end of the incision which had opened, and around the milk-worm-gut resection sutures. The edges of the opened up incision were severely inflamed.

The jejunostomy tube, which had been clamped off until now was used for feedings. One thousand cubic centimeters of 25 per cent glucose and 1000 cubic centimeters of 4 per cent salt solution were injected at intervals. The eleventh day the dressings were changed every half hour and the skin was protected with zinc oxide ointment and kaolin powder but the skin became more excoriated and painful beyond endurance. At this time, jejunostomy tube and oral administration of relquefied reolac were used. Six ounces of this milk mixture were given by mouth and

8 ounces by enterostomy tube every 2 hours for 8 doses daily. Intravenous glucose of 10 per cent solution, which had been given every other day now was given daily, and hypodermoclysis was continued. Treatment remained the same from the twelfth to seventeenth day. Some of the milk powder solution presented itself at the fistulous opening as it was being injected into the jejunostomy tube. About one third escaped through the opening and about two-thirds found its way to the lower bowel. This could be more or less regulated by the speed with which it was injected.

The wound was left open about 3 hours twice a day and the whole abdomen exposed to the rays and heat of a therapeutic light. The discharge from the wound drained to the side into fluffed dressings, which were changed when soiled. The fistulous opening was strapped tightly with sterile adhesive and zinc oxide ointment applied to the skin. By the eighteenth day there was very little drainage and none on the nineteenth day when the patient was allowed to sit up in a chair (Fig. 3). From the twenty-second to the thirtieth postoperative days, the milk powder feedings were continued, and in addition a glass of orange was given by mouth every 4 hours. On the thirty-first day the enterostomy tube was removed and the patient was up and about. On the thirty-fourth day the wounds were all healed and the patient was discharged from the hospital.

*Notes.* There was duodenal drainage from the fourth to eighteenth postoperative days, slight at first, with no tryptic action manifested until the ninth day when there was profuse drainage. The amount of discharge was estimated about 2 liters per day. Following the administration of the buffer milk solution there was immediate improvement. Drainage continued and gradually stopped on the eighteenth postoperative day.

#### SUMMARY OF MANAGEMENT OF CONSERVATIVE TREATMENT

The treatment under consideration applies only to the acute duodenocutaneous fistula. Small chronic fistulas, duodenocolic fistulas, and other internal fistulas are not taken into consideration here.

##### *The anticipatory treatment*

1 Such a large percentage of acute duodenal fistulas follow perforated duodenal ulcer and known traumatism to the duodenum that it seems feasible to establish a well functioning jejunostomy at the same time that the primary operation is being performed.

2 The building up of the nutritional and chemical reserve by administering (a) Continuous hypodermoclysis of normal saline solution, (b) daily intravenous infusion of 10 per cent glucose in salt solution, a liter a day for several days after any operation entailing the suturing of the duodenum thus the patient is systemically prepared for the rapid toxemia and inanition, should the formation of a fistula ensue.

3 Avoidance of drainage material when possible. If drainage material is used, it should be soft rubber drainage material of the Penrose type, without gauze through a stab wound in the right



Fig. 1. left. Illustrating the case of control of drainage by strapping, when bulk of the fistulous discharge makes its exit through a stab wound.

Fig. 3. Taken on the nineteenth postoperative day. Fistula healed.

flank. It should be placed in such a manner that it is distant from the suture line in the duodenum.

##### *After the fistula is evident*

1 As has been noted in some cases following duodenal surgery, there is a slight seepage of what appears to be intestinal secretion. Very little proteolytic action upon the skin and tissues is shown at first but suddenly there may be a copious discharge, representing probably the entire duodenal secretion. Immediate treatment for duodenal fistula should be instituted when fistula is suggested by the first appearance of the duodenal secretion. One should not wait until the drainage becomes profuse.

2 Replacement of chloride and sodium ions and fluids by intravenous and subcutaneous saline administration.

3 Nutritional maintenance by administering (a) Intravenous glucose (b) feedings through the jejunostomy or duodenal tube, (c) feedings of re-liquefied milk powder of 8 ounces every 2 hours, for eight times, injected into the jejunostomy tube. Concentrated glucose solution can be added if additional nourishment is needed also, concentrated saline solution to aid in chloride replacement, and lubricants to aid in elimination of the lower bowel.

4 Administration by mouth of 6 ounces of re-liquefied milk powder every 2 hours, for eight times daily, for its buffer effect on the proteolytic action of the duodenal secretion, before it leaves the duodenum.

5 Strapping of wound. Tight strapping of the fistulous opening of the abdominal wall provided there is no free pus in the discharge. After the straps are applied care should be taken so that the skin is protected from the secretion. This can be accomplished with zinc oxide ointment or kaolin powder.

## CONCLUSIONS

1. That a buffer solution of milk, milk modification or reliquified milk concentrate given by mouth at frequent intervals will

a. render the duodenal secretion less innocuous to the sinus, abdominal wall and skin before it leaves the fistulous opening in the duodenum

b. dilute the duodenal secretion which has been buffered by the oral administration of milk to the extent that it will lessen its proteolytic action on the skin or soft tissues

c. thicken the duodenal secretion. It has been noted that the greater the fluid content of the discharge, the more irritating it is to the tissues of the abdominal wall.

2. When the reliquified milk powder solution is given by mouth, it is not necessary to use tenth-normal hydrochloric or other acids to lessen the alkalinity of the duodenal secretion nor is it necessary to use oil or fat in addition to the amount it contains.

3. The principle of tightly strapping the fistulous opening in the abdominal wall with adhesive plaster should be energetically employed.

## BIBLIOGRAPHY

1. ALEXANDER, JOHN J. Perforated ulcer of the duodenum, with duodenal fistula. *Atlantic M J* 1926 (Aug) 783-784.
2. BERO, A. A. Duodenal fistula: its treatment by gastrojejunostomy and pyloric occlusion. *Ann Surg.*, 1907 xiv 72-739.
3. BONNER, JOHN V. and MILLET, ATTILIO. Duodenocutaneous fistulae. *Ann Surg* 1931 (June) 174-190.
4. CAMERON, A. L. Treatment of duodenal fistula. *Surg. Gynec. & Obst.*, 1913, xxviii, 599-606.
5. CHEEVER, DAVID. Concerning traumatic rupture of the duodenum and duodenal fistula, with the report of a case. *Boston M. & S J* 1905, clxxviii, 454-457.
6. COLE, RALPH. External duodenal fistulae. *Ann Surg* 1913, lxxviii, 725-744.
7. LINDMAN, S. Laceration of the duodenum duodenal fistula. Jejunostomy feeding; parotiditis feeding recovery. *Ann Surg.*, 1913, lxxviii, 703-707.
8. GRUBBS, JOHN J. Duodenal fistula. *J Am M. Ass* 1930, xciv 250-260.
9. GRUBBS, G. E. and STROGGER, EMANUEL. Perinephric abscess and fistula formation in connection with the gallbladder: report of two cases. *J Am M. Ass* 1930, xciv 2050-2053.
10. HAYES, R. L. and ORR, T. G. The cause of certain acute symptoms following gastro-enterostomy. *Bell Johns Hopkins Hosp* 1913 xxxiv 26-30.
11. JONASSEN, N. A. Duodenal fistula, the treatment and report of a case. *Northwest Med* 1927 xxvii.
12. KAMAVEL, A. B. Duodenal toxemia following rupture of the duodenum, with remarks on extraperitoneal rupture and a report of two cases. *J Am M. Ass* 1914, lxii, 759-760.
13. KITTELSON, JOHN A. The treatment of duodenal fistula, including a report of two cases, and a report of a new buffer solution. *Ann Surg* 1933 (June).
14. KROGER, WILLIAM P. Interduodenal fistula. *Am J Surg* 1931 xlii, 291-293.
15. LAUREY, F. H. The treatment of duodenal fistula by suction. *Surg Clin N America*, 1914, iv 1489-1492.
16. LOCK, MAXWELL. Duodenal fistula: report of a case. *Atlantic M J* 1915 (Sept.) 9-112.
17. MCGUIRE, STUART. The treatment of duodenal fistula. *Surg. Gynec. & Obst.*, 1930, xxx, 450-461.
18. PARSONS, C. A. Contribution to the treatment of duodenal fistula, with the report of a successful case. *Lancet*, 1914, i, 1109-1111.
19. PARSONS, W. H. Duodenal fistula. *N Orleans M & S J* 1920, lxxviii, 29-32.
20. POTTER, CARYL. The treatment of duodenal fistula; report of a case. *J Am M. Ass* 1927 lxxviii, 899-901.
21. Idem. Treatment of duodenal and fecal fistula, further observations. *J Am M. Ass* 1929, xcii, 159-163.
22. Idem. Treatment of duodenal, high intestinal and pancreatic fistulae. *J Missouri M. Ass* 1931 (Aug) 374-378.
23. REED, CLARENCE. Duodenocolic fistula with incompetent sphincter of oddi. *J Am M. Ass* 1913, c, 496-497.
24. SALMON, J. M., and GARDNER, W. L. Treatment of duodenal fistula, report of a case. *Kentucky M J* 1930, xxviii, 112-116.
25. WALTERS, WALTER and BOLLMAN, JERRE L. The toxemia of duodenal fistula. *J Am M. Ass* 1927 lxxviii, 1849-1853.
26. WALTERS, WALTER, KILGORE, ALAN M., and BOLLMAN, JERRE L. Changes in the blood resulting from duodenal fistula, a clinical and experimental study. *J Am M. Ass* 1926, lxxviii, 86-180.
27. WALTERS, WALTER. Duodenal fistula: the effect of the loss of gastric, duodenal, pancreatic, and biliary secretions from the body. *Surg. Gynec. & Obst.* 1927 xiv 840-841.
28. WORTHEN, THOMAS W. Duodenal fistula. *New England J Med.*, 1930, cclii, 76-77.

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.

ALLEN B. KARAVEL, M.D.

LOYAL DAVIS, M.D.

Managing Editor

Associate Editor

Associate Editor

DONALD C. BALFOUR, M.D.

Associate, Editorial Staff

APRIL, 1934

#### CONCERNING THE SUTURE

WHEN Galen recommended a ligature of Scottish linen thread which could be bought at a certain shop on the Via Sacra he displayed one of the attributes of a surgeon, that is, fastidiousness in the selection of the materials with which he works. Unfortunately in the case of the suture this more often rests upon tradition or intuition than upon knowledge or insight into the problems involved. Even in these days of the scientific method surgeons swear by or at various types and kinds of sutures without any material reasons for the opinions which they express. Yet, the reasons for using a suture and the conditions which surround its employment seem almost axiomatically apparent. It should not be difficult to select the kinds of material and the way to use them.

The first necessity is obviously tensile strength but strength apporportioned to the functions which the suture is supposed to perform rather than to the physique of the operator. In general these functions are the binding of blood vessels, the relief of tension, and the approximation of tissues.

In the first instance, the object to be achieved is the staying of the flow of blood until the vessel becomes firmly thrombosed. The force required for the closing of even a major vessel, as one can determine by compressing the radial is not great in fact less than five pounds. Even the lightest ligature has this much strength. Failure comes not from breaking of the ligature but from its being slipped by the pulsation of the vessel. This may be avoided by applying a crushing mass ligature in which case it must be so strong that it can scarcely be broken by the operator. Preferable however, is the application by transfixion of a light ligature which produces much less destruction and leaves less non living material in the wound. With the small 'spurs' ordinarily encountered transfixion and tie or tie alone with the finest ligature available is ample assurance against further bleeding.

In the second group it is a generally accepted principle that sutures the function of which is to carry tension should not be used in the wound itself for approximation. These are of necessity heavy and non absorbable and preferably impermeable. Therefore they must be removed but only after the danger period of 10 to 14 days is over. Such heavy material buried in the wound will in most instances lead to delayed healing, abscess formation and in many instances extrusion of the suture material.

Lastly it is equally apparent that the approximation of tissues must be obtained without tension on the line of healing. If tension is unavoidable this must be taken up at points at a distance from the incision. The question



here is what size and type of suture should be used in holding the tissues in approximation and the answer is obviously the lightest which will serve this purpose. Certainly it is stupid to use one which is stronger than the tissue through which it passes. Fascia will rarely sustain a suture pull of more than five pounds and this is likewise true of tendon while C twisted silk of a standard grade has a tensile strength of six pounds and 00 catgut an equivalent amount. Any sceptic may readily test this statement *in vivo* by passing such a suture through either fascia or tendon and pulling until it breaks or pulls out—it will be the latter. If this is true for these dense tissues it is much more so for muscle and fat and one is not justified in using anything but the finest sutures in these structures. To employ as is customarily done heavy braided silk or No. 2 catgut in approximating wounds is as unintelligent as mooring a rowboat with a ship's cable.

One may answer however that there is no harm in using heavier material and thus playing safe. Unfortunately safety is not increased by doing this but rather decreased. Any suture material has two faults which cannot be entirely avoided. The one is that it acts as a nidus for infection frequently present in the wound or perhaps more frequently on the operator's gloves by reason of his having handled the skin. The larger the suture the more difficult it is for the scavenger cells of the body to reach these organisms and overpower them and if not absorbed the situation persists indefinitely. This is the peculiar defect of the unabsorbable suture so if used as little as possible must be put into the wound. In other words one must employ only the finest twisted silk with interrupted rather than running stitches, square knots cut on the knot and taking only small bites of tissue. The other objection to the use of heavy

sutures, that of tissue irritation applies only to the absorbable type for the customary non absorbable material such as silk or linen by reason of its lack of absorption is not changed in the tissues and therefore is non-irritating. Wherever it is taken to be such, there is infection present, as in Lister's original experiment which gave origin to the idea that silk was a tissue irritant. On the other hand when one studies in section even the finest suture of absorbable material, there is always present some degree of reaction about it for the process of absorption involves the breaking down of collagen into soluble protein or protein derivatives which excite an inflammatory reaction. When the mass of the material present is small this is inconsequential in fact less than that entailed in the trauma by the incision itself but as the mass increases the situation soon reaches a seriousness comparable to the presence of an hematoma or of gross necrotic tissue. Under these circumstances, sterile abscesses may be found and if the suture lies at all near the surface, it or at least the knot may be extruded. Less obvious but none the less true is the more rapid decline in the strength of the suture in the presence of such increased digestive reaction. With infection the whole process is accelerated so that the strength of the suture quickly disappears but in contrast to the non-absorbable suture leaving no nidus to shelter the organism present.

From this consideration one arrives at certain conclusions. The surgeon should not use a size of suture material materially greater than the holding power of the tissue involved. This will diminish in the unabsorbable suture the 'nidus effect' in the absorbable suture the irritating results of its digestion. The non-absorbable suture should be used only in case asepsis is impeccable and in such a fashion as to leave only isolated minute bits

of suture material. The absorbable suture while not rendering refinement of technique any the less desirable, permits rougher handling of tissues, a certain degree of infection and a grosser but more rapid technique, with out in most instances materially increasing the disability of the patient. On the other hand, the non-absorbable suture enforces meticulousness on the part of the surgeon so that he becomes more of the artist though none the less a craftsman.

SAMUEL C. HARVEY

## PAINFUL LESIONS OF THE SPINE

**K**NOWLEDGE of the pathologic conditions that underlie painful back is slowly increasing. Probably no single contributor has done more in recent years to advance this knowledge than has Schmorl. His work "Die Gesunde und Kranke Wirbelsäule im Röntgenbild" covers the subject in a comprehensive but concise manner. Many of the facts have been known for a long time but Schmorl has elaborated on them so as to bring about greater understanding of their importance.

The intricate structure of the spine, together with the difficult approach to it, from the viewpoint of pathology have prevented its receiving its share of attention in the advance of medical knowledge. Pathologists are seldom interested in studying it unless it has some very obvious lesion. They will take great pains to recover the spinal cord for study but they seldom save any portion of the spinal column itself. It is to be hoped that with the coöperation of orthopedic surgeons more efforts may be made to improve on existing knowledge of the spinal column through direct study of pathology, correlated, when possible, with clinical facts.

The importance of pathologic conditions of the intervertebral disks in the production of symptoms has gained widespread recognition. Perhaps this has been overemphasized as is natural when interest in a subject is wide spread. It is known that the nucleus pulposus can be and is ruptured in many cases, without apparent symptoms. Undoubtedly however there are cases in which rupture causes definite symptoms. The erosion or narrowing of this disk in many cases of lumbosacral strain is now recognized and the same type of narrowing may be seen in all parts of the spine in cases of traumatic or other types of arthritis. Enlargement of the disk is an other condition observed in nearly all cases in which the vertebral bodies are extensively involved by disease and particularly when the diseases are those which produce extensive osteoporosis. Some writers claim that this process is an inflammatory one involving the disks themselves. The more plausible explanation is that the reduced strength of the bodies allows expansion of the disks to take place in some cases to extreme degree.

The destructive lesions of the vertebral bodies are fairly well recognized and understood. With present methods in roentgenology much can be read from a well made roentgenogram. There is however, a group of cases which can be recognized, but the etiology of which is obscure. These are the cases in which there is a painful condition of the spine and in which there is roentgenologic evidence of varying degrees of osteoporosis with, in many cases pathologic fractures of one or more vertebrae. Some of these no doubt are due to osteomalacia and perhaps some are due to parathyroid tumors, in either case other bones are involved as a rule. In other cases no apparent involvement of other bones can be demonstrated, but the spine may be extensively involved.

The attempt to throw all of these cases into the category of changes in bone resulting from hyperparathyroidism has failed. While the parathyroid glands have a very important function to perform in calcium metabolism yet present knowledge does not permit all of these atrophic lesions of bone to be so catalogued. One easily can surmise that the condition mentioned may in some way be connected with disturbances of the parathyroid glands but when these cases are thoroughly analyzed no evidence is found in the laboratory data of any undue excretion or retention of calcium. In the light of present knowledge therefore we can presume only some remote connection between this condition and the parathyroid glands.

One cannot regard the spine as being composed only of bone and cartilaginous disks. The more one studies the spine the more one must be impressed by the importance of the articulations of the posterior bony structures which compose what is commonly known as the neural arch. These are true joints which have three functions to allow movement to take place to act as stabilizers to prevent forward slipping of the vertebrae on each other and to form a part of the protective bony cage around the spinal cord and nerve roots. Their structure and function is such as to subject them to many stresses and strains. For this reason traumatic arthritis may involve many of these joints. One has only to examine a small series of spines to be impressed with the changes which take place in these joints, changes which must in many instances, produce symptoms.

In order to recognize the presence of these changes, one must admit the presence of traumatic arthritis, an entity the existence of which many investigators have denied. The preponderance of the results of careful investigation is in favor of the belief that there is such a condition. It can be produced experimentally. Anyone who frequently operates on joints of man must admit the presence of changes which can be ascribed only to traumatism. Articular cartilage is present over all moving joint surfaces. It acts as a cushion and smooth, gliding surface. Strangely enough it has no blood supply so that repair takes place slowly and inadequately. Degeneration of the cartilage except under certain conditions, is likewise slow. With its degeneration, however permanent change appears, and the joint which is subjected to this change is never quite normal again. It is the cartilaginous change in these joints of the spine which is primary. Bony changes come secondary to these, but once established, the joint is more vulnerable than before. It will function normally under average stress or strain but under abnormal stress or strain reaction takes place followed by symptoms.

These three types of lesions are among the more recently recognized causes of painful conditions of the spine. Their importance may at present be overemphasized yet in many instances it is perhaps through overemphasis that proper recognition of the importance of a fact is obtained. Once this is recognized the fact becomes established in more or less common knowledge and receives adequate recognition. R. K. GORMLEY.





*William Taylor*

# MEMOIR

---

## SIR WILLIAM TAYLOR

THE sudden death, January 30 1933, of Sir William Taylor of Dublin, an honorary Fellow of the American College of Surgeons, came as a great shock to his many friends over the world.

Sir William was born in County Donegal, September 21, 1871, and received his early education at The Strabane Academy. His later academic distinctions and his long service at the Meath Hospital have been recorded in the *Lancet*, as follows:

"Sir William Taylor in the medical schools of the Irish Royal Colleges and the University of Dublin proved himself a distinguished student by securing the gold medal of operative surgery and the Mayne scholarship. From the University of Dublin he received the M.B. degree in 1901, having previously secured the F.R.C.S., Ireland. He was appointed assistant surgeon to the Meath Hospital in 1898 and as full surgeon in 1900. He was consulting surgeon to this hospital at the time of his death so that he had given it life long service."

Many honors were accorded Sir William in his own country, and last year, 1933, he was to serve as president of the surgical section of the British Medical Association which met in Dublin. He was elected to the Council of the Royal College of Surgeons in Ireland, and in 1914 was vice-president and president in 1916. On the outbreak of the war he was accorded the rank of colonel, Royal Army Medical Corps. He was one of the surgeons to the Dublin Castle Red Cross Hospital, and at the request of the War Office he organized a hospital in France, selecting the staff from men too old for rigorous service. During the war he was indefatigable, and his energy and skill while working with the "83 (Dublin) General Hospital" at Boulogne was recognized with the C.B. in 1917 and the K.B.E. in 1918.

In 1922 Sir William became Regius Professor of Surgery at Dublin University, and in 1923 surgeon to Sir Patrick Dun's Hospital. He was president of the Association of Surgeons of Great Britain and Ireland in 1924-1925 and was president of the Royal Academy of Medicine in Ireland in 1927. In addition to his posts at the Meath Hospital and at Sir Patrick Dun's Hospital he was consulting surgeon to the Coombe Lying in Hospital, the Stevens Hospital, and the Dental Hospital of Ireland. As was said in the *British Medical Journal*, "Few

men can have combined so many important posts or acquitted themselves in their multifarious obligations with greater ability

The papers which he presented before various meetings in North America, and his contributions to medical and surgical literature were obviously based on large experience and this, with his sound common sense gave great weight to his opinions in many fields of clinical surgery. Those who have been privileged as I have been to visit his surgical wards at Sir Patrick Dun's Hospital, and other hospitals of Dublin will recall the wide range of his surgical knowledge, his technical skill his directness, and his forceful teaching. These qualities in a man of his engaging personality made such visits never to be forgotten.

William J Mayo in speaking of a visit to Dublin in 1923 wrote of Sir William as a gifted teacher and surgeon. Dr Mayo continued I have heard him give a graphic description of infantile intussusception stressing the sudden crying out of the child the pallor the vomiting and the explosive movements from the bowels. In none of his cases has he had recurrence after operative reduction. In performing splenectomy in cases of anaemia he immediately transfuses the free blood in the spleen to the patient. He has had noteworthy success in handling cases of acute obstruction of the bowel using a high enterostomy with two tubes, for the purpose of emptying the toxic contents of the bowel and of nourishing the patient.

Honors came to Sir William not only at home but abroad and it was on the occasion of his first visit to this continent that he was made an Honorary Fellow of the American College of Surgeons at the meeting in Montreal in 1920 and he gave the Fellowship Address that year. It was at this time that Sir William, Sir Berkeley Moynihan and Mr A. Carless, representing the Consulting Surgeons of the British Armies in the World War presented the Great Mace to the American College of Surgeons.

Sir William was elected an Honorary Member of the American Surgical Association in 1924 and in 1927 the degree of LL.D. was conferred on him by McGill University. He had a real admiration for American and Canadian medical schools and teaching and the affection in which he was held by the surgeons of these countries was fully reciprocated. His great personal charm vivacity wit, friendliness and exuberant good health made him always welcomed as a visitor in America by his many friends in and out of the medical profession. Those who had the privilege of knowing Sir William Taylor can understand the tribute of a colleague who wrote of him 'Honest in his work, honest in his dealings with all men and fearlessly faithful to his convictions his passing is a tragic loss to his profession and to his country.

DOUGLAS C. BALFOUR.

# EARLY AMERICAN HOSPITALS

## "OLD BLOCKLEY"

TEMPLE FAY M.D. F.A.C.S. PHILADELPHIA

WOVEN into the history of the Philadelphia General Hospital is the inception and evolution of American medicine. "Old Blockley," as it is familiarly known to many of the profession, has exerted an influence on the entire field of medical and institutional development in this country. The first organized unit for the care of the sick and needy to be founded on the American continent, it has continued its unique position of leadership as an institution of its kind even to the present intensely modern era.

Every member of the American profession enjoys some common bond which links him to the traditions and early influences of this source and center of medical education. "Old Blockley" has come to assume the place in American Medicine that Independence Hall holds as a shrine in our national and political history.

Twenty nine years after the landing of William Penn and the founding of Philadelphia, the Monthly Meeting of the Society of Friends, set aside two city lots, each 51 feet by 260 feet on the south side of Walnut Street between Delaware Third and Fourth Streets' (4) for the use of poor members of the Society of Friends. Several stone cottages were built for the care and comfort of their impoverished members, and in 1729 a larger building was added on Walnut Street which became known as the Friends Almshouse.

Coincident with this early provision for the poor by members of the Society of Friends, and probably stimulated by their example, there arose the need for care of those who were not members of the Society and yet presented an urgent problem of civic responsibility.

In 1712 Councils passed a resolution which declared: "The poor of the city Daily Increasing it is ye opinion of this Council that a workhouse be immediately hired to Employ poor Persons and sufficient Persons appointed to keep them at work." (5)

In 1729 the city recommended the application for relief and the Legislature resolved to "loan the Mayor and Commonality, one thousand

pounds to be applied to the purchase of ground and the erection of an Almshouse or Hospice for the use of the poor of the city.

The money was received in 1730 and a square of ground known as the Green Meadow bounded by Third and Fourth, Spruce and Pine Streets was purchased from Alden Allen, for two hundred pounds, and a brick building was erected in 1731 or 1732 known as the Philadelphia Almshouse which was to house the poor the sick, infirm and the insane. (5)

This became the first large structure in America to be set aside for hospital purposes and although combining the Almshouse until 1919 the evolution of a hospital service such as is enjoyed today was an object and example which founded the basis of our modern concept of hospitalization. Sir William Osler states

This venerable institution, originally the Philadelphia Almshouse, which in 1742 was "fulfilling a varied routine of beneficent functions, has just claim to be the oldest hospital in the States. Having migrated twice during the growth of the city it finally in 1834, moved from the "Bettering House" in what is now the heart of Philadelphia, to a farm in the suburbs in the then township of Blockley on the West side of the Schuylkill. Here, far out in the country, the indigent poor and afflicted, the alcoholic and insane of Philadelphia came to be housed—went over the hills to the poorhouse.

It was the selection of the latter site, known as Blockley and named by Captain Warner in 1658 after his old home in England later to become Blockley Township which gave to the present institution its familiar sobriquet.

Rich have been the contributions of this oldest American institution for the care of the poor and infirm. Although the records of its early years are obscure, it must be borne in mind that its influence and possibilities in the teaching of medicine were appreciated long before the American Revolution. Agnew (1) states

In 1742 it was fulfilling a varied routine of beneficent functions in affording shelter, support, and employment for the poor and indigent, a hospital for the sick, and an asylum for the idiotic, the insane and the orphan. It was thus dispensing its acts of mercy and blessing when Pennsylvania was yet a province and her inhabitants the





Fig. 1 House of Employment, Almshouse and Pennsylvania Hospital, from an engraving by Hallett. (From Packard, Surg. Gynec. & Obst., 93:1-96)

loyal subjects of Great Britain, more than twenty years before a school of medicine was founded in this city and indeed before most of the great events which have given the American people a historical importance among the nations of the earth.

The Pennsylvania Hospital was founded in 1753 as a private institution affording the best medical care to the acutely ill which could be established at that period. The parallel course that these two institutions maintained throughout their years of service has been a constant source of stimulation to each.

It must be borne in mind that the leading physicians of that day attracted to themselves one or more pupils who learned the art of medicine through personal instruction and completed their medical courses abroad, returning to take up their practices in Philadelphia, imbued by the teachings and knowledge of the great medical centers, particularly that of Edinburgh.

Thomas Bond, Cadwalader Evans, Adam Kuhn, Benjamin Rush, John Morgan, and William Shippen were among the leading minds of the profession at that date. It seemed almost inevitable that with the hospital facilities afforded by the Philadelphia Almshouse and the Pennsylvania Hospital, the move toward instruction in clinical medicine should have been given impetus and that there should have evolved the desire for a medical school.

In 1766 Bond is credited with delivering the first clinical lectures in medicine and surgery at the Pennsylvania Hospital. In 1770, and perhaps even earlier Cadwalader Evans and Bond established the first obstetrical clinic at the Philadelphia Almshouse for "students of good character" and in 1772 the managers were solicited to extend the

medical conveniences of the house for better accommodations of the students. Thus the Philadelphia Almshouse, as it was then known, became linked with the teaching of medicine from its earliest days. The care of its inmates was placed in the hands of the leading physicians of the time. With the founding of the department of medicine, College of Philadelphia, the first medical school arose on this continent. The teachers of medicine as members of its staff have found a fertile field for clinical research that has given rise directly and indirectly to the great contributions of American medicine.

The Medical School of the College of Philadelphia, later to become the University of Pennsylvania School of Medicine, was organized in 1765 by Doctors John Morgan and William Shippen. On March 25 1774, Adam Kuhn, professor of *materia medica* and botany in the Medical College, and Benjamin Rush, who held the chair of chemistry and Samuel Duffield, one of the ten Alumni who received the first medical degree on the 21st of June, 1768 and Girardus Clarkson and Thomas Parke were added to the staff of the Philadelphia Almshouse, and this was probably the origin, in this country of gratuitous professional service to the public, confined to charitable institutions.

It will be seen that the valuable clinical material among the 350 persons then housed within the confines of the institution became the basis for clinical teaching and the source from which the American-schooled physicians found their first concept of applied medicine.

Those who passed through this early training received the benefits of clinical observation from the Philadelphia Almshouse, and in the years



Fig. 2 Aerial photograph of Philadelphia General Hospital. (Through the courtesy of Dallin Aerial Surveys, Philadelphia.)

that followed, many of these men who graduated in medicine from the University of Pennsylvania became the founders of other medical institutions throughout the country, wherein the importance of their early training and experience was handed on to other generations or became interwoven into the rapidly spreading fabric of American institutions and the subsequent progress of medicine which progressively followed in the wake of this early source of learning.

It is interesting to note that Cadwalader Evans, in 1771, recognized twenty-one children within the institution who had not suffered as yet from small pox, and petitioned the Board of Managers for their isolation and inoculation. The privilege was granted by the Board with the understanding that no expense would be involved other than the cost of the medicines used.

On September 5 1776 the Managers of the Bettering House, as it was then known, received a request from the Council of Safety to permit the quartering of a number of Continental militia who were very sick with dysentery. This request was strenuously opposed by both the Managers and the medical attendants, as calculated to endanger the health of the inmates, but military possession was taken of the Almshouse in spite of these protests, on October 23, where the troops remained until 1777 when the British took possession of the city and forced their removal. General Howe immediately appropriated the entire east wing of the Hospital for the care of the King's troops. The poor and dependent were driven to the west wing which the managers attempted to

prevent being taken over in a similar manner through the good offices of Joseph Galloway. However, about nine o'clock at night, in November 1777, orders were received to clear the west wing for the reception of the King's troops. The Board of Managers, meeting next morning, refused to comply with the request, but the British proceeded at once to remove the inmates, about two-hundred miserable, decrepit, and half-starved creatures. These would soon have perished from exposure had not the managers succeeded in securing quarters for them in the Freemason's old lodge, the Friends' Meeting House, and in Carpenter Hall where they were maintained until the last days of June, 1778 following the evacuation of Philadelphia by the British. Of the original two-hundred who were ejected from the building, only eighty-two survived to re-enter their former quarters. During this unsettled period, teaching had been abandoned as is evidenced by the petition received in November of 1778 when a formal application was made to the physicians of the Almshouse for permission to witness the practice in the institution. Their petition was at first denied, but upon reconsideration of the subject at which time the advantages of hospital instruction to the profession in the community were presented, they urged at least a probationary trial and through the efforts of Doctors Rodgers and Leib who volunteered a personal responsibility for the good conduct of the young men in attendance, the decision was reversed, and the Bettering House was opened by a majority of one vote for a continuation of clinical instruction.

tion. During this year forty additional children were inoculated for small-pox and isolated all successfully recovered.

On March 5 1780, an outdoor relief was instituted for those who were not inmates of the house, yet who were dependent upon the institution for relief and in 1781 the records seem to indicate that Samuel Duffield appeared to be the only attending physician, under conditions as they existed at that time.

In 1787 the Reverend Manasseh Cutler published in his *Journal* (Vol. I pp. 253-285) his experiences while visiting the hospital with Dr. Garardus Clarkson, then a member of the staff. He writes,

"We returned to Philadelphia, between ten and eleven o'clock. When we came to the hospital, Dr. Clarkson left me and went into the city on his son's horse. Young Mr. Clarkson conducted me into the hospital, (the young Mr. Clarkson referred to is in all probability the William Clarkson who later became a member of the staff.) Doctor Rush arrived in a few minutes after. The building is in the form, as you approach it from the city, of an inverted T. It is surrounded with a high wall, and has back of it a very large kitchen garden. The door in the center opens into a large hall. On each end are apartments for the nurses, cooks, etc. We ascended the stairway out of this hall into another hall in the second story at one end of which is a large room, which contains a fine medical library where the directors were sitting, and a smaller room where the medicines is placed. On the opposite end are the apartments for the attending physicians. The third floor is formed in the same manner. On one side of this hall is the Museum, where there is a collection of skeletons and anatomies.

After we had taken a view of the Museum, we returned to the upper hall, where several physicians and all the young students in physics in the city were waiting. Doctor Rush then began his examination of the sick, attended by these gentlemen, which I judged to be between twenty and thirty. We entered the upper chamber of the sick which is the leg of the T. It is a spacious room finely ventilated with numerous large windows on both sides. There were two tiers of beds, with their heads toward the walls, and a small chair and small table between them. The room was exceedingly clean and airy, the beds and bedding appeared to be of good quality and the most profound silence and order were preserved upon the Doctor's entering the room. There were only women, and about forty in number. Doctor Rush makes his visits with a great deal of formality. He is attended by the attending physicians who give him account of everything material since he saw them last, and by the apothecary of the hospital who minsters his prescriptions. We next took a view of the maniacs. Their cells are about ten feet square, made as strong as a prison. On the back part is a long entry, from which a door opens into each of them. From this distressing view of what human nature is liable to, and the pleasing evidence of what humanity and benevolence can do, we returned to the rooms where the doctors were. The scene I had now been attending upon was totally the reverse of that of Gray's, but such is the elegance of these buildings, the care and attention to the sick, the spacious and clean apartments and the perfect order in everything, that it seemed more like a palace than a hospital, and one would almost be

tempted to be sick, if they could be so well provided for. We then took a view of the bettering house which is a large and spacious building with good rooms and well furnished.

In 1788, a system of residenship was established which was the forerunner of our present system. The medical department was reorganized and an apothecary appointed. An epidemic of small-pox broke out within the institution, in spite of the rigid observance of isolation, the outcome of which became one of the sad chapters in the history of this great institution, as vaccination had not as yet been discovered and the idea of inoculation was in general public disfavor.

In 1789 clinical teaching at the hospital was discontinued because of the hostile attitude assumed by the Board of Managers, and in this year appointments were made from the house students who served both to dispense medicines and attend the patients on the wards.

In 1793 the great epidemic of yellow fever broke out in Philadelphia, and more than 17,000 of its inhabitants fled the city. Thousands upon thousands of cases occurred and a large plot of ground, now Washington Square, was used as a Potter's Field, and to this day contains the bones of those who passed their few remaining days within the wall of the Bettering House at the height of this epidemic.

In 1798 yellow fever again visited the city and more than 50,000 inhabitants left because of its disseminating activity. Whooping cough also reached the proportions of a pestilence at this time.

In 1802 three apothecaries were in attendance at the Hospital and a system of junior and senior physicians was then introduced. Yellow fever again appeared in the community but because of strict quarantine measures the incidence of cases was confined to only a few. During this quarantine the resident pupils were forbidden to visit the city proper.

In 1803 the first ward instruction was permitted and permission granted to Doctors James and Church to attend the lying in wards and entertain one private student at each case of labor. On March 23 of this year Dr. Caldwell was allowed to instruct a class of twenty later forty students during his visits to the medical wards. He was made responsible for the conduct of the students, who at that time, were generally regarded with suspicion. On October 25 1805, a fee of eight dollars was charged for instruction given to the visiting physicians, although office pupils of the attending staff were permitted to receive instruction free.

In November 1806, the managers granted the privilege of delivering clinical lectures twice a week in the Green, or 'Dead House,' during the winter season. Dr Barton was given permission to lecture to his classes on his days of attendance. It is interesting to note that in this year the former prejudices of the Board of Managers had greatly lessened and their desire turned toward making provisions for more adequate care of the sick and better institutional possibilities. They petitioned the State Legislature for aid and cited that The Pennsylvania Hospital rich in estates, had repeatedly received assistance from the munificence of former legislatures, and was at that time before the assembly for help and yet its doors were closed against the poor, and more than an equivalent for board and lodging exacted. The Almshouse on the other hand, not only cared for those who came from the city and county of Philadelphia, but one fifth of the inmates were from other parts of the Commonwealth. Besides, the Almshouse containing over one thousand inmates, presented an extensive field for communicating medical instruction to students attracted to it from all parts of the country by the celebrity of the school (2).

On May 9 1808 a medical library was started and one hundred and fifty dollars appropriated for the purchase of books. The senior resident physician was made librarian. A second appropriation of one hundred and fifty dollars followed in 1810. This year was noteworthy for the admission of the first female resident, a Mrs Lavender, a midwife to the Bettering House.

In 1811 additions were made over the dye and wash house to permit two wards of twenty or thirty beds each and one lecture room to be added, and the lectures were later held in these new quarters. In 1813 the first discordant note arose in the form of rivalry between the Pennsylvania Hospital and the Almshouse. Success of the Almshouse as a medical school became handicapped because the Managers ruled that anyone holding an appointment on the Pennsylvania Hospital Staff was disqualified from holding a similar one at the Almshouse. This type of petty discrimination has its frequent counterparts in medicine of our day, which clearly shows that beneath the surface a feeling of rivalry and jealousy had made its appearance among the various members of the two prominent hospital staffs. Students holding tickets were permitted to attend a case of labor at this time. Three hundred dollars was expended for books for the library and a fee of thirty dollars permitted life privileges for use of the library.

Small-pox broke out to alarming degrees in the city of Philadelphia during 1823 and a special house on Bush Hill was provided for the care of those suffering from this dreaded disease. This represents the first inauguration of an isolation or contagious hospital in this country and is historic because of the direct interest and personal service rendered by Stephen Girard.

In 1824 competitive examinations were instituted for candidates desiring house positions, and in 1827 the privilege was granted to Doctor Thomas Harris to deliver didactic courses in surgery, although not connected with the clinical instruction of the institution. In this year Dr Horner presented the library with 120 theses from Edinburgh. There were approximately seventy five students in attendance at that time.

In 1829 Dr Gerhard a member of the staff perfected the thoroughness of physical examination and exploration by means of auscultation and percussion, and he is considered the father of this technique in America. It was on January 1 of this year that the site of the Hospital was purchased from Henry Beckett and his wife for the sum of \$51 528 12½. This tract was in Blockley Township and as mentioned before, the name Blockley was bestowed upon this region by Captain Warner who settled it in 1758.

In 1832 an outbreak of cholera led to closing of the hospital doors to new cases and the nurses then in attendance became so panic stricken that they were replaced by Sisters of Charity, who remained in the institution until 1853. A card of admission, still in existence, calls for admission on August 22 1833 and although the new buildings were not occupied until October 1 of this year, this was supposed to be the first card of admission issued for the new building. In 1834, two hundred and twenty students were in attendance, and the revenue derived from this source amounted to one thousand four hundred twenty dollars.

Jefferson Medical College which had been organized in 1825 had grown into considerable importance and a request was made, in the year of 1834 to the Guardians of Blockley to allow the students of Jefferson Medical College an equal status with those of the University of Pennsylvania, in regard to clinical teaching. The trustees of Jefferson Medical College asked for two wards, one medical and one surgical, and alternate weeks for their clinical lectures. Those representing the interests of the University objected to such an arrangement as calculated to mar the harmony of the school and the hospital. They declared that they had undertaken the development of a clinical school at a time when scarcely a ticket

was sold, and that they had succeeded in making it a source of revenue to the Board.

In 1835 it is noted that the day of instruction was changed from Wednesday to Saturday in order to accommodate the men from Jefferson Medical College, numbering seventy-nine students, who sought clinical instruction at Blockley. In this year the need for a definite name for the institution was recognized, and Mr. Hansel, a member of the Board, proposed that it be called the Philadelphia Hospital. This recommendation was seconded and the medical department of the hospital has been known by this name since that time.

In 1836 the library contained 3000 volumes and proved to be the finest collection of ancient and modern medicine and surgery probably in existence at that time. Doctor Gerhard demonstrated, after careful study of intestinal lesions, the differential points between typhus and typhoid fever.

In 1841 an addition was made to the hospital for the care of infectious diseases, the building being located on the west side of the main structure. Here patients might be observed and those suffering from contagion isolated.

The importance of the school as a great clinical center in America had reached a high point in 1845. The lecture room was capable of holding from 700 to 800 persons, and yet, the teaching of clinical medicine at the Philadelphia Almshouse was abruptly interrupted for a period of 9 years because of the unceremonious slaying of a cock roach at the steward's table by the student physicians then boarding within the hospital. To quote from Dr. Agnew the incident throws some light upon the hospital, its organization, and its direction at that time. He states (6)

The 30th of June, 845, is somewhat memorable in consequence of the culmination of a trouble which had been developing for some time. The resident physicians were boarded at the table of the steward, where, as I understand, in consequence of the want of due formality and decorum in the destruction of an unfortunate cockroach which had rashly taken a near cut across the table instead of going around, these gentlemen became indignant, and demanded of the managers to be transferred to the table of the matron. Their refusal to comply with this request determined a unanimous resignation, leaving the hospital unprovided with any medical assistance. The evening of that day Doctors Horner and Clymer attended and prescribed for the sick. Here was a *corps belli*, and the managers promptly passed a resolution of dismissal.

With the hope of adjusting these differences and bringing about a partial reconciliation, a joint meeting was called for July 2nd, at which Doctors Jackson, Horner, Clymer, Gillingham, and Pascoe attended, representing, as a committee, the medical board. Doctor Jackson, who seemed to have been the advocate in the case, spoke in behalf of the committee, urging the managers to allow the

residents to remain, at least until their places could be properly supplied, declining to pass any censure or later here in any matter of personal conflict between the residents and Guardians, as foreign altogether to their legitimate jurisdiction. The Guardians, however, were intransigent, and refused to recede from their vote of dismissal, thus forever closing the doors of compromise. The seceders, after retiring, availed themselves of the columns of the *Lodge* newspaper in which there appeared a card betraying, to say the least of it, a good deal of youthful indiscretion.

On the same day of this meeting, Mr. Flanagan offered the following resolution: "Resolved, That the hospital committee be requested to look into the expediency of reorganizing the medical department of the house, and report to this board." On the 21st of July the report was made, which, after going over the ground of the trouble, recommended the abolishment of the medical board and the substitution of a chief resident and assistant resident physician, and two consulting physicians and surgeons. On the 15th of September the report was taken up and passed, modified as follows:—After the first of October, 1845, there shall be one chief resident physician, with a salary of \$1800 per annum, one consulting surgeon, one consulting physician and one consulting accoucheur, each at a salary of one hundred dollars a year."

What great results proceed from small and unlikely causes! Who would have ever thought that the official existence of a medical board, composed of ablest men in their various departments on the continent, could have depended on the life of a contemptible cockroach? In this manner the doors of the Philadelphia Hospital, as a school of instruction, were sealed for nine years.

During this interval, in 1851 the hospital admitted the first woman physician to its staff in the person of Doctor Sarah Adamson, appointed May 25 of that year. Subsequent attempts were made to return to the medical board system and abolish the position of chief resident physician, but these failed of accomplishment.

In 1854, the doors of the hospital were again opened to clinical instruction and the event was celebrated by the students throughout the streets of Philadelphia. Tickets to the clinics were fixed at ten dollars including transportation for two days a week for four months. Arrangements were made with the railroad which ran cars from Broad and Market Streets to a point opposite the buildings to carry the students on the days of clinical lectures.

In 1856 there were 75 students in attendance at the hospital, but the clinics failed to meet their own expenses. In this year Dr. Archibald B. Campbell describes the hospital as comprising "A small-pox hospital, a lunatic asylum, a children's asylum, a lying-in department, a nursery, a hospital for medical, surgical, venereal, and mania & p<sup>s</sup> cases, besides the almshouse properly so-called. These departments were not under specialized supervision. In the year 1857 the entire medical visiting staff including six resident physicians resigned when Dr. James McClintock was appointed chief resident. He

was alleged to be engaged in the production of medicinal preparations, whose contents were not known and for this, among other reasons, he was frowned upon by the medical board.

On November 22, of 1858 the petition of medical students of the city to resume lectures was acceded to and in 1859, a new board was appointed by the courts. This board comprised of intelligent and liberal men entered upon a program of reform. They disposed with the office of chief resident and appointed a medical board of twelve members to act as physicians, surgeons, and obstetricians, each to visit the institution four times a week. This reorganization of the Board of Guardians removed it from the politics-ridden influence of the day and made possible its advance into the great clinical school of medicine in this country.

In 1860, the wards were opened for free clinical instruction and Doctor Agnew was appointed curator of the newly founded pathological laboratory. In 1863, the feeble minded children were separated from the general group at Blockley and sent to the Training School at Media.

In 1874, an increase in the number of attending physicians on the surgical and obstetrical staffs was effected and the superintendent recognized as in charge of the insane department.

In 1877, the neurological department was founded which was to bring fame to such men as S. Weir Mitchell, Charles K. Mills, Francis Y. Dercum, Henry Lloyd, William G. Spiller and Charles W. Burr, due to their devoted work and study in the field of nervous and mental diseases, the greatest source of their inspiration and material being secured from the patients in the wards for nervous diseases of the Philadelphia Hospital. Departments of ophthalmology and dermatology were also instituted at this time.

From 1877 until 1884, corps of nurses from the training school of the Woman's Hospital of Philadelphia served in the institution in an efficient, enthusiastic, and faithful manner acquiring wide experience and supplementing the haphazard method which had been in existence prior to this time at the institution, due to the use of former patients and male nurses, usually selected through political influence.

The year 1884 is memorable in that on July 28 Miss Alice Fisher formerly superintendent of the General Hospital in Birmingham, England, and recommended by Florence Nightingale, was secured as superintendent of nurses to organize a training school at the Philadelphia General Hospital. Through the influence of citizens such as Anthony J. Drexel, George W. Childs and Rich-

ard C. McMurtre, she was able to establish, with the help of Miss Horner whom she selected as assistant, classes for student nurses. Although she died 4 years later the training school had been so well organized and directed that her assistant, Miss Horner found little difficulty in carrying on the high and efficient standards which Miss Fisher had instituted. There followed in the history of the training school a succession of brilliant women who conducted the hospital along the most modern lines of nursing until its plan and its organization have been models for other institutions which arose in later years. Miss Marian E. Smith was a member of the first graduating class in January 1886, and later became superintendent of the hospital where she brought into accomplishment the full program of her teacher and her predecessor. Miss Smith later became superintendent of the University of Pennsylvania Hospital, where her keen knowledge of nursing and medical supervision combined to give this institution first rank among the hospitals of the country.

In 1890 the hospital was divided into four departments, medical, surgical, obstetrical, and neurological, with special wards under the care of dermatological, laryngological, ophthalmological, venereal, alcoholic, and other specialized departments which had been added as the progress of the times indicated their necessity. In 1890 the medical and surgical staffs consisted of eight members each, the neurological of four, with two ophthalmologists, two dermatologists, two laryngologists, a pathologist, and a bacteriologist. The medical board has been elected annually in December since the creation of the new Department of Health and Charities, and the appointments made by the director of the department.

Medicine throughout this country has been profoundly influenced by the work and teachings of Sir William Osler and it must be borne in mind that here within the walls of "Old Blockley" he performed thousands of autopsies and made his great pathological and clinical observations which made him the recognized authority in medicine, not only in his day but to the present time. This contribution alone binds the medical profession to the Institution which made available the vast amount of material which came under Dr. Osler's direct observation and analysis.

Under the leadership of Doctor Furbush and Doctor Krusen, as directors of Public Health, the hospital has found its most modern expression. The new additions and organizations have been carried out under the superintendency of Dr. Joseph C. Doane and Dr. William Turnbull so

that the 'Old Blockley' of today is a monument of modern medical science completely housed within new and elaborate buildings and augmented by a huge Municipal Hospital for Contagious Diseases as well as a large institution for the Insane, situated at Byberry in the suburbs of Philadelphia. The history of "Old Blockley" from 1890 to the present time is within the knowledge of most of the profession today. The tremendous influence which it has exerted upon the medical profession of America may be realized to some extent when one recalls that with the advent of this institution as an Almshouse there arose the possibility for clinical teaching of medicine with the founding of the first medical school in America.

The physicians who founded the University of Pennsylvania in 1765 were notably John Morgan and William Shippen, Jr. Doctors Adam Kuhn and Benjamin Rush joined them to form the first teaching staff of that institution. These men all received their training in Edinburgh and returned to Philadelphia to practice. Their teachings were absorbed by the younger men who benefited by the clinical experience gained at the Almshouse, and went forth to practice according to the precepts and teachings which they had received colored as they were by the methods of caring for the sick, then in existence, and stimulated to better things by the defects which they observed.

It is not surprising that the graduates who passed through this early institution of learning and who received their medical experience in the wards of the old Almshouse should have been inspired to organize new centers of learning, so that one may trace among the founders of 29 of our large medical schools of today the names of men graduated from the University of Pennsylvania and Jefferson, and who instituted in their new schools the influences received from their student days at "Old Blockley."

The "Philadelphia Almshouse" has exerted its influence directly or indirectly on the majority of medical institutions of learning in this country. Later known as the "Better House," and finally by the familiar term of "Old Blockley" it stands today in the majesty of two hundred years as an historic beacon to light the path of medical progress under the formal designation of the Philadelphia General Hospital.

#### REFERENCES

1. ADKINS, D. HAYES. The Medical History of the Philadelphia Almshouse. History of Blockley Philadelphia. F. A. Davis Company 1920, p. 5
2. Ibid. p. 26
3. Ibid. pp. 31-32.
4. CROSBY, JOHN WELCH. Introduction. History of Blockley Philadelphia. F. A. Davis Company 1920, p. 1
5. Ibid. p. 2.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

IT is rather a novel compliment to Barling who is professor of surgery in the University of Birmingham, to be listed as co-editor of a pediatric "system" which must essentially be largely medical. Forty-six authors, who are English with the exception of one Canadian and several Americans, have collaborated in the production of *Diseases of Infancy and Childhood*<sup>1</sup>. The two volumes totalling 1798 pages are very compact in view of the fact that pediatric medicine and surgery are adequately covered. This is largely due to the fact that English medical authors seem to possess the desirable trait of omitting the tedious tables of statistics which clutter up so many American textbooks. Added to this is a fluidity of style and sufficient injection of personality to add materially to the reader's enjoyment.

Of course, there occur minor differences in the approach to certain problems as compared to ideas prevalent in America. Citing an example Spence's attitude that subjects of intracranial birth injuries usually die or recover without sequelae would be open to serious question in this country. Nor is Harnes blanket endorsement of Dick serum and the minimizing of the virtue of convalescent human serum in the treatment of scarlet fever acceptable to the average American pediatrician. Among his five indications for surgical intervention in acute mastoiditis Williams lists (1) pain fever or tenderness persisting 48 hours after onset of discharge, (2) edema, and (3) otorrhea persisting 4 weeks from the start. His viewpoint seems rather radical.

Among its many virtues the work includes brilliant word pictures of various clinical entities. This applies particularly to the contagious. As might be anticipated the sections on rheumatism tuberculosis, and heart disease are exquisitely done. Sir Humphrey Rolleston's treatment of blood dyscrasias is lucid and understandable, when one considers the confusion surrounding that topic at the present time. Surgical entities discussed at length include cleft palate hare-lip and orthopedic conditions. Psychical disorders of the nervous system is disappointing in that it would seem to retain an organic rather than the functional approach being adopted by American psychiatrists and pediatricians. The fault of overlapping discussion of the same subjects has obviously been studiously avoided except in the handling of pulmonary tuberculosis heart disease, and nutritional disorders of infancy.

An appendix of 50 diversified radiograph plates terminates this very worth while textbook.

JAMES H. WALLACE.

FROM the observations and experience gathered together from many authorities upon the subject of gastro-enterology Arafa<sup>2</sup> presents what he considers the modern methods of investigating and treating problems involved.

In the first two chapters the author gives detailed methods of accurate history taking physical examination and radiological technique both of a normal and a pathological stomach, also he shows the value of gastric analysis and the various means and methods of examining the gastric contents. The instruments used and their value in securing a more direct view of the stomach are discussed.

Chapters III and IV deal with chronic gastritis and peptic ulcer. Various methods of making a differential diagnosis of these conditions are discussed in full and methods of treatment are suggested including the general principles of the diet that should be correlated with the medical treatment.

The subject of intestinal disease is opened with a discussion of the clinical physiology of the intestinal tract and its relation to the stomach and its functions. The same general plan of presenting what the author considers the most valuable methods of diagnosis and treatment is carried out.

In Chapter VIII is discussed cholecystography and duodenal intubation. The technique and interpretation of the results are given special consideration. Dr. Knott has also given a discussion on the method of examining the contents of the duodenum.

Chapter IX covers a study of the pancreas, its clinical physiology and pathological lesions.

The chapter on simulation of the gastro-intestinal diseases stresses the important fact that in order to study and treat diseases of the stomach and intestines intelligently one must bear in mind the manner in which diseases of other organs of the body reflect their symptoms on the alimentary tract.

The last chapter is devoted to practical dietetics. A general discussion is given on food and the three principal classes of food—protein carbohydrates, and fat. A brief general discussion is given to the dietotherapy in gastric and intestinal disorders.

The book is simply written should interest the general practitioner and, for a quick review the student of gastro-enterology. C. J. BARBORKA.

<sup>1</sup>DISEASES OF INFANCY AND CHILDHOOD. By LEONARD C. PARKES, M.D., F.R.C.P. and SCYMOER BARLING, M.B., F.R.C.S. Vols. I and II. New York and London: Oxford University Press, 1933.

<sup>2</sup>MODERN ASPECTS OF GASTRO-ENTEROLOGY. By M. A. ARAFA, M.R.C.P. (Lond.) With Foreword by Arthur F. Horst, M.D., F.R.C.P. Baltimore: William Wood and Company, 1933.



A VERY happy combination for dealing scientifically with the subject of football injuries is had in the collaboration of two men like Stevens and Phelps<sup>1</sup> since the one is not only a football coach and player but also a surgeon, and the other an orthopedic surgeon, possesses the technical skill and knowledge peculiar to that subject.

The first chapter which deals with training and physical equipment has some very apt remarks in it. Although enthusiastic for football, the authors say "Players who have injuries should not be allowed to participate in either scrimmage or a game. If he conceals such a fact from the trainer or coach (or doctor) he not only does harm to himself, but handicaps his team." And again when an injury does not yield to accepted treatment within a reasonable time (under the doctor) the players may seek men not well qualified to treat their injuries, and fall victims to quacks of various sorts, and be grossly maltreated. Players should not be allowed in any case to be treated outside, without consulting the physician in charge. The only way to control football injuries is for competent men to have absolute charge of the injuries and their treatment." And again "It is a most annoying sight to see a number of coaches or trainers yanking and hauling at a player's leg in a blind effort to pull something back into place, a something with which they are entirely unfamiliar and utterly incompetent to handle, despite the fact that reduction is usually a very simple matter in the hands of an experienced physician."

THE CONTROL OF FOOTBALL INJURIES. By Marvin Allen Stevens, M.D., and Washburn Morgan Phelps, M.D. New York: A. S. Barnes and Company 1933.

Smoking, drinking, and sexual indulgences are advised against. Rest, plenty of sleep, conditioning exercises and physiotherapy properly supervised, are recommended.

The bulk of the book is taken up with the different types of injuries. Motion picture films illustrate the mechanisms by which most of the injuries are produced. Anatomical and scientific descriptions are given of the parts involved, and "skills" and techniques are outlined by which injuries can be avoided. The authors lay great emphasis on the necessity of keeping the parts of the body well under control during activity as many injuries are acquired by awkward players, or players "loafing."

In the case of given injuries, diagnostic signs and symptoms are pointed out. Repeatedly the use of the X-ray is urged when in doubt, and consultation or treatment by specialists is advised. Special treatment is then outlined for the different injuries. The book is quite up to date, the latest approved treatment for various conditions being given as is the case of recurrent dislocations, the Nikola operation is advised and has been done with success.

Finally, several tables of statistics on football injuries and deaths and careful analysis of them are given.

The authors are not only to be congratulated upon their book, which is the first of its kind and should act as a textbook for coaches and trainers as well as for physicians interested in athletic injuries but are also to be congratulated upon their attitude of always keeping in mind that the individual comes first, and the athletics are purely secondary.

MARCUS H. HOWART.

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

SAN FRANCISCO CANCER SURVEY: EIGHTH PRELIMINARY REPORT. By Frederick L. Hoffman, LL.D. Newark, N. J. The Prudential Insurance Company of America, 1933.

THE GLASGOW ROYAL MATERNITY AND WOMEN'S HOSPITAL. Medical Report for the Year 1932. Prepared by D. McK. Hart, M.B., Ch.B. F.R.C.P.S.G., M.C.O.G. Glasgow: Aird & Coghill, Ltd., 1933.

THE ORIGIN OF CANCER. By J. P. Lockhart Mummery M.A., M.B., B.C. (Cantab.) F.R.C.S. (Eng.) London: J. & A. Churchill, 1934.

THE CLINICAL MANAGEMENT OF HOBBS-KIDNEY. A STUDY OF HOBBS-KIDNEY DISEASE, ITS ETIOLOGY, PATHOLOGY, SYMPTOMATOLOGY etc. By Robert Gutierrez, A.B. M.D. F.A.C.S. With a Foreword by Dr. Edmond Papin. New York: Paul B. Hoeber Inc., 1934.

A TEXTBOOK OF THE PRACTICE OF MEDICINE. By various authors. Edited by Frederick W. Price, M.D., F.R.S. (Edin.) 4th ed. New York and London: Oxford University Press, 1933.

MONOGRAPHS OF THE BAKER INSTITUTE OF MEDICAL RESEARCH. No. 2. The Spread of Tumours in the Human Body. By Rupert A. Wilson, M.D., B.S. D.Sc. London: J. & A. Churchill, 1934.

MONOGRAFIE E TRATTATI DI BIOLOGIA E DI MEDICINA. Under the direction of Prof. Carlo Foa. TRATTATO DI RIGENERAZIONE E DI CURA TERAPIA. Directed by Felice Petrucci and Enzo Pugno-Vassoli. Vols. I and II. Milano: Fratelli Treves Editori, 1934.

A TEXT BOOK OF GYNECOLOGY, FOR STUDENTS AND PRACTITIONERS. By James Young, D.S.O., M.D. F.R.C.S.E., F.C.O.G., 3d ed. rev. ed. New York: The Macmillan Company: London: A. & C. Black, Limited, 1933.

TREATMENT IN GENERAL PRACTICE. By Harry Beckman, M.D. 2d rev. ed. Philadelphia and London: W. B. Saunders Company 1934.

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVIII

MAY, 1934

NUMBER 5

## TUMOR OF A SUBCUTANEOUS GLOMUS

TUMEUR GLOMIQUE, TUMEUR DU GLOMUS NEUROMYO-ARTÉRIEL SUBCUTANEOUS PAINFUL  
TUBERCLE ANGIO-MYO-NEUROME SUBCUTANEOUS GLOMAL TUMOR<sup>1</sup>

MICHAEL L. MASON M.D., F.A.C.S. AND ARTHUR WEIL M.D. CHICAGO

THE tumor of the subcutaneous glomus is a rare, but benign and interesting neoplasm which most frequently occurs under the nails of the fingers and occasionally of the toes though it has been found in numerous other locations of the upper and lower extremities. It is characterized clinically, by painful crises radiating from a small bluish tender, subungual or subcutaneous tumor and pathologically by a peculiar angioma like structure, richly furnished with myelinated and unmyelinated nerve fibers. The tumor is perfectly benign, is removed with ease by surgical excision, and has never been known to recur.

The tumor of the neuromyo-arterial glomus has been recognized as a distinct pathological entity only since the publication of Masson's study in 1924. Since that time a number of reports have appeared in the French literature and an occasional report (one each) in the Spanish, English, and German literature. So far as we have been able to determine no such tumor has been reported, as such, in the American literature. It is not at all improbable, however, as Greig has suggested that the tumor has been recognized by its peculiar clinical characteristics and confounded with a neuroma under the name of painful subcutaneous tubercle while pathologically it has gone under the designation of angioma per-

itheloma, angiosarcoma, false neuroma, etc. The ordinary laboratory methods in preparing and staining sections with hematoxylin and eosin would not demonstrate certain of the variable peculiarities of these tumors. The peculiar clinical history gives the necessary clue since it is absent in the case of the usual angiomas and neuromas.

The following history illustrates many of the salient features of the tumor.

J. M., Passavant Memorial Hospital, No. 15666. The patient, a male 56 years of age, had entered the hospital for surgical treatment of a Dupuytren's contracture. While convalescing from the operation he requested that a small tumor be excised from the left knee. He stated that the lesion had been present for 37 years and followed a bicycle accident in which he had struck the knee on a steel rail. He sustained a very painful contusion without however any laceration of the skin and without any infection subsequently. The acute symptoms subsided under massage and a liniment, but 1 week following the first injury he felt striking the same knee. Following this injury the spot was very sensitive and painful for many weeks. After the acute symptoms had subsided a small bean-sized mass remained. This mass or tumor was extremely sensitive and tender as well as spontaneously painful. During periods of pain the patient thought the tumor was more blue than during quiescent periods. If the tumor was struck there was a sensation in it like a bee sting and occasionally on standing erect there would be a sticking sensation in it. There had been no increase in size of the tumor since its development, however the patient had been able to reduce its size by mas-

<sup>1</sup>From the Department of Surgery and the Institute of Neurology, Northwestern University Medical School. Read at the clinical meeting of the Chicago Surgical Society, February 2, 1934.

sage or pressure. If the skin was drawn taut over it the tumor would appreciably diminish in size only to regain its original dimensions within 24 hours.

Examination revealed a small bluish discoloration resembling a thrombosed vessel just beneath the skin over the lower and lateral border of the left patella. The area was only slightly raised and palpation revealed a small mass about 3 millimeters long elastic in consistency and movable in all directions in the subcutaneous tissues. It was evident that we were dealing with an unusual tumor one having some of the characteristics in appearance of an angioma and in clinical symptoms of a peculiar neuroma. There was however some definite physiological activity of the mass periodic engorgement, compressibility with slow return to normal size which did not quite fit in with either diagnosis. Despite the unusual location a tentative pre-operative diagnosis of a tumor of an arteriovenous glomus was made.

Under local anesthesia the skin and subjacent tumor was excised by Dr. Allen B. Kanavel. Grossly the tumor was bluish red in color and definitely demarcated from the surrounding tissues (Fig. 1) and although its superficial surface seemed to be attached to the subcutaneous fat the deep surface separated easily from the underlying tissues. There was seen a long thin vessel in the subcutaneous tissues over the patella which ran from above downward under the tumor to end in its lower pole.

The recovery following the operation was uneventful. Immediately following the extirpation of the tumor the patient stated that all the subjective sensations described above had completely disappeared.

Microscopic examination demonstrated that we were dealing with a tumor with unusual histological structure resembling that of a cavernous hemangioma but with certain differences which at once confirmed our suspicions that we were dealing with a glomus tumor.

The tumor which measured approximately 5 millimeters in its largest diameter was situated in the subcutaneous tissue (Fig. 2). It was surrounded by several layers of loose collagenous connective tissue fibers which

however were not condensed into a definite capsule.

It contained numerous smaller and larger blood vessels from small capillaries up to a size of 2 millimeters in diameter. They were lined with a single layer of endothelium mostly flat elongated cells which also assumed round or cuboidal shapes. Separated from this endothelium by a few fine connective tissue fibers there followed a stratum of several layers of different cell types. In the minority of the vessels this outer cellular wall was composed of elongated cells with oval nuclei (Fig. 3). In most of the others it consisted of several layers of large epithelioid cells with an oval or round well staining nucleus containing one or two sharply defined nucleoli. The cytoplasm of these cells remained clear and stained only faintly with eosin. Intermingled with these epithelioid cells were smaller more spindle shaped forms (Fig. 4). Their elongated nuclei were darkly stained with hematoxylin or cresylviolet and from the scanty cytoplasm, processes were seen streaming from both poles of those cells. Occasionally one might observe epithelioid cells embedded in a homogeneous matrix a picture resembling somewhat cartilage formation.

In sections stained with Perdrau's method (Fig. 5) or van Gieson's method one saw a dense meshwork of fine fibers which encapsulated the epithelioid cells and which also formed coarser strands of fibers between the different vessels. In silver stained preparations (Davenport's method) one detected between the connective tissue fibers isolated myelinated and unmyelinated nerve fibers (Fig. 6). They entered between the epithelioid cells and could be seen streaming toward the inner wall of the blood vessels. Occasionally one found endings in the form of small buds or a branching out into a fine meshwork (Fig. 6 a and b). At the outer periphery of the tumor a large nerve fascicle was seen composed of myelinated and unmyelinated fibers.

The tumor was a somewhat bizarre copy of a glomus coccyeum, or of the neuromyo-arterial glomus (Fig. 8) of the subungual tissue or of the subcutaneous tissue of the extremities. Those formations represent a venous-arterial anastomosis (von Schumacher

Grosser Masson) which is characterized by the presence of large epithelioid cells replacing the media of the vessels such as have been described in our tumor (Fig 4). The significance of these cells has been frequently discussed. Older authors considered them to be glandular cells and accordingly thought the glomus coccygeum to be a gland with internal secretion. Others described them as embryonic smooth muscle cells which were able to contract, thereby decreasing the lumen of the vessels. Since Krompecher's histological and embryological studies of the human glomus coccygeum it appears more probable however, that they are embryonic rests of angioblasts mesenchymal derivatives which have advanced to the stage of elastoblasts. They do not form smooth muscle fibers and they are not contractile, but they form on their surface an elastic membrane, which is continuous with the membrane of the neighborhood cells. Such a meshwork surrounding the epithelioid cells in our tumor could well be demonstrated in sections stained with Perdrau's method (Fig 5). It lends support to Krompecher's theories.

The condensation and homogeneous staining of the tissue surrounding the epithelioid cells producing the picture of cartilage formation and which has been described above has also been seen by former investigators in the wall of normal arteries and has been found by Masson in his tumors of the neuromyo-arterial glomus.

The second type of cells intermingled with the epithelioid cells, the dark staining cells described above (Fig 4) sending out processes at both poles have suggested ganglion cells to some observers. However we were not able to stain these cells and their processes prominently in silver preparations though at the same time myelinated and unmyelinated nerve fibers were well outlined in other places of the same section. It is possible therefore that those cells are merely somewhat darker staining shrunken smooth muscle fibers.

In summary, one may state that the tumor described is a hyperplastic glomus which is differentiated from the normal structure by its abundance of epithelioid cells and the absence of regularly arranged layers of smooth



Fig 1. Gross appearance of tumor normal also. Sketch showing the under surface of the skin with the subcutaneous fat within which the tumor lay embedded. The lower pole (at right) and the superficial surface were attached to the subcutaneous tissues, whereas the upper pole and the deep surface were but slightly attached. Counting from above downward deep to the tumor was a long thin blood vessel which ended in the lower pole of the tumor.

muscle fibers. Since it arises from a normally present structure one should classify it rather as an hamartoma or a hyperplasia than as a blastoma.

Such formations have been occasionally described in the literature though, as herein pointed out already frequently under a different histological diagnosis.

Attention was originally directed to these tumors by a report of a case by Barré in 1920, of extensive and violent sympathetic disturbances caused by a small subungual tumor of the left middle finger. We are indebted however to P. Masson, of Strasbourg, for a careful study of the histology of the tumor and for the identification of its source. Since the publication of Masson's first paper in 1924 a number of other cases have been reported so that up to the present time 27 cases are recorded in the literature. To this group of 27 (which with this case can be brought up to 28) we have added 6 further cases (1 reported by Kolaczek in 1878 in his monographic contribution on angiosarcoma, 2 reported by Kraske in 1880 and 1887 respectively also as angiosarcoma following the lead of Kolaczek 2 of Barré's cases reported in 1922, and Carsten's case of subungual angiosarcoma reported in 1927) which are probably the same type of tumor. Greig in 1928 reported 3 personal cases and collected reports of 15 others. He made the suggestion that it seemed probable that many instances of the subcutaneous painful tubercle mentioned especially by the older surgeons were in reality tumors of the neuromyo-arterial glomus and recorded a number of such cases reported in the *Edinburgh Medical Journal* during the past century. We have made no attempt to collect case reports of subcutaneous painful tubercle, but there is no



Fig. 2. Section through tumor, subcutaneous tissue, and epidermis. Demonstrates the vascular structure which is separated from the environment by a loose capsule of connective tissue fibers. (Cresyiviolet stain.  $\times 3$ .)

doubt that such a study would be rewarded by the finding of many glomus tumors.<sup>1</sup>

DaCosta's description of painful subcutaneous tubercles certainly coincides in many respects with the clinical picture of these tumors. "Violent pain occurs in paroxysms and radiates over a considerable area of which the tubercle is the center. These paroxysms may occur only once in many days or many times in one day. Pain is always developed by pressure and may be linked with spasm. Nerve fibrillae are now known to exist in these tubercles, a fact which was long denied.

The clinical history and physical findings in instances of tumors of a subcutaneous glomus are almost always the same so that once seen the condition should be easily recognized. The patient may or may not give a history of trauma. If such a history is given the immediate effects of the injury will have subsided before the symptoms of the tumor appear. The onset is characterized by attacks of pain limited to a certain area of skin or to a finger



Fig. 3. Section through tumor to demonstrate the numerous blood vessels of different shapes which are lined by a flat endothelium and surrounded by the epithelioid cells described in the text. (Cresyiviolet stain.  $\times 15$ .)

tip. These painful attacks occur in crises which as time goes on become more and more frequent and more and more severe. At the onset there is usually no visible lesion but later a bluish nodule makes its appearance at the site of the pain. If the tumor is located under the nail the pain is especially excruciating and may and often does radiate up the arm to the neck and face and may even involve the whole side of the body. The pain is described as lancinating or stabbing like a sewing machine needle passing through the finger (Barré) or it may be burning. Not infrequently it is worse at night. In some instances relief may be obtained by immersion of the hand or part in warm water and in some instances cold affords relief. Touch or pressure of the nodule sets off a crisis so that the patient comes to "live in terror of the tender spot" and if the lesion is on the hand the use of this member may be much impaired. The patient may be nearly driven to distraction the painful paroxysms may interfere with sleep the general health may suffer many pounds in weight may be lost (25 kilograms in a patient of Bonnet's) and life may be made so unbearable that suicide may be contemplated. The pressure of clothing over the spot may set up a paroxysm and in the case of thigh tumors the patient may carry the hand in the pocket to protect the tumor from trauma (Prodanoff). So severe may the symptoms be that in a case of Barré's a diagnosis

Chandler, in 1888, carefully reviewed the question of painful subcutaneous tubercles and studied four tumors histologically. The technical names of his (supposed) series of cases credit to him correspond to those of our common body and wrist tumors. He did, however, record in his descriptions nerve fibers in several such tumors, and noted the increased vascularity in one. Some of the tumors were carcinoma simulators and he remarked that Paget and others had noted that during some of the course of the tumors became blue or violet.

Recent (good) study of painful subcutaneous tumors reports a number of cases, several of which might well have been glomus tumors.

of cord tumor was seriously considered. Curiously enough in Picard's case the patient did not complain of any pain. Changes in temperature such as passing from a warm room to the cold outdoors may initiate a crisis while warmth may alleviate the pain.

Upon examination (in case of the subungual tumor) there will be seen beneath the nail a small bluish discoloration while the nail itself may be raised and more convex than normal. There may be a slight linear deformity of the nail distal to the tumor. An X ray examination of the finger may show a definite indentation of the distal phalanx. If the tumor lies beneath the skin there will be found a smooth rounded, bluish mass under the normal skin. During painful crises the color of the tumor may deepen (Greig) and become more blue. The subcutaneous tumor may look and feel like a small thrombosed varix. There may be a slight rise in the local temperature of the part affected. In a case described by Masson there was a Horner's syndrome on the same side as the tumor.<sup>1</sup>

There is nothing of any particular significance known concerning the general etiological factors in this tumor. In about 40 per cent (36.2 per cent of cases in which the information is given) of the cases there has been a history of trauma while in the remaining ones the onset has been spontaneous. The condition is about equally distributed between the two sexes (18 female 14 male 2?) and the ages of the patients vary from 18 to 82 years. The condition has been present for from 6 weeks to 37 years before the correct treatment has been instituted though many patients have sought relief in vain for many years.

With one exception all of the glomus tumors so far reported have been located on the extremities. Of 34 cases of tumors in 21 instances the tumor was located on the upper extremity, 1 was located over the acromion, 11 on the lower extremity, and in 1 instance the location was not given. Of the 21 involving the upper extremity 17 were on the hand and of these 14 were subungual.<sup>2</sup> 1 involved the palmar surface of a finger, 1 the dorsal sur-

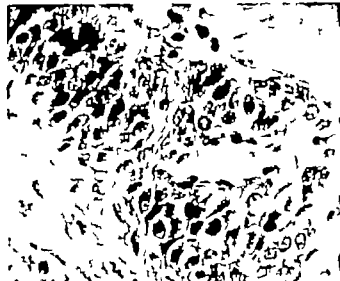


Fig. 4. Higher magnification of a blood vessel, demonstrating the endothelial lining and the surrounding epithelioid cells with their large, oval, darkly stained nuclei and nucleoli and the faintly stained cytoplasm. Notice the scattered dark staining, spindle shaped cells with processes radiating from both poles. Light green-fuchsin iron haematoxylin stain (Masson's triple stain)  $\times 465$ .

face of the left index finger close to the nail and 1 lay in the palmar fascia. Of the 4 others affecting the upper extremity 3 were on the forearm and 1 was at the insertion of the deltoid muscle. Of the 11 on the lower extremity 6 were on the thigh, 3 on the leg, 1 under the nail of the great toe and 1 on the sole of the foot.<sup>2</sup> Statistics show a slight pre-dominance of the left side—13 left and 11 right in 24 instances in which the information is recorded.

The tumor grossly forms a soft pink fleshy well defined usually elongated mass varying in diameter from 1 to 5 millimeters and in length from 3 to 12 millimeters, located wholly or in part in the cutis vera or in the subcutaneous tissues. Not infrequently a small circular opening the central artery is seen in the under surface. The tumor may be easily shelled out of the surrounding tissues, and if it is subungual is seen to lie in a definite shallow concavity beneath the nail though it is not usually possible to demonstrate a definite capsule. If a capsule is present it is probably developed as a secondary reaction of the surrounding tissues as suggested by Martin

<sup>1</sup> Masson states that complete cure followed the removal of the tumor but does not definitely state that the Horner's syndrome disappeared.

<sup>2</sup> The subungual tumors were distributed as follows: thumb, 1; index, 3; middle, 3; ring, 2; and little finger, 1; 21 left hand, 71 right, 41 ?.

<sup>3</sup> Of the 1 on the upper extremity there were 1 on the left side and 6 on the right, in 5 the side was not designated. Of the 11 on the lower extremity 3 were left and 8 were right, while in 3 this information was not given.



Fig. 5 Section through tumor to demonstrate the abundant argyrophil mesenchymal fibers which surround the epithelioid cells and which form strands of coarser fibers in the spaces between two vessels. Perls's stain.  $\times 300$ .

and Dechaume and is not infiltrated by the tumor. If the tumor is subungual the bone of the distal phalanx may be indented but is not invaded. Neighboring pacinian corpuscles may be flattened and compressed.

The microscopic picture of these tumors resembles more or less closely that given of our own case. Masson described two types of vessels differentiated by the cells which form their walls. In the first type a layer of well defined smooth muscle fibers follows the endothelial lining and the thin band of the underlying connective tissue fibers. They pass gradually through transitional forms to epithelioid cells. In the second type the more numerous, the inner layer of smooth muscle fibers is absent and the circular ring of connective tissue is directly bordered by layers of epithelioid cells and only occasionally are isolated ramified smooth muscle fibers seen intermingled with these epithelioid cells. The histological pictures of our own case give a good illustra-

tion of this second type of blood vessels (Fig. 4). Surrounding the cellular vessel wall is a loose connective tissue containing numerous myelinated and unmyelinated nerve fibers. Masson states that these nerve fibers show intimate connections with the epithelioid cells. We could not convince ourselves that such pericellular or endocellular endings existed in our tumor. We found free endings between the epithelioid cells or endings in the form of bulbs or fine meshworks, but we did not see a direct continuation of cellular processes with unmyelinated nerve fibers as described by Masson.

The relative amount of smooth muscle fibers, of blood vessels or of nervous elements may have been the decisive factor in former cases, in leading to the diagnosis of myoma, hemangioma, or even neuroma. Dupont has pointed out such varying histological pictures in an analysis of three subcutaneous glomus tumors. The presence of the epithelioid cells

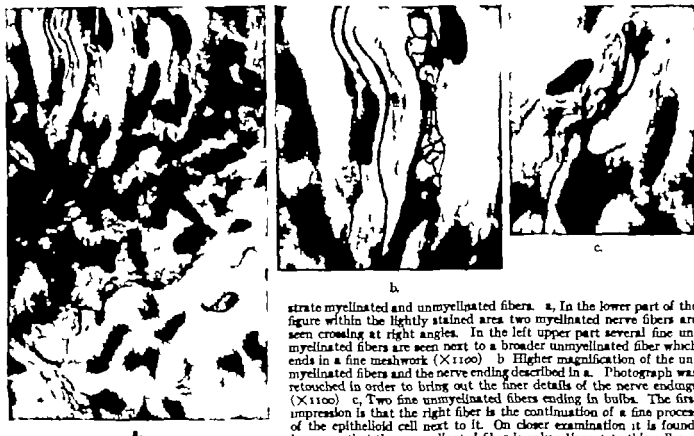


Fig. 6. Sections through tumor stained by Davenport's method for nerve fibers, to demon-

strate myelinated and unmyelinated fibers. a. In the lower part of the figure within the lightly stained area two myelinated nerve fibers are seen crossing at right angles. In the left upper part several fine unmyelinated fibers are seen next to a broader unmyelinated fiber which ends in a fine meshwork ( $\times 1100$ ). b. Higher magnification of the unmyelinated fibers and the nerve ending described in a. Photograph was retouched in order to bring out the finer details of the nerve endings ( $\times 1100$ ). c. Two fine unmyelinated fibers ending in bulbous structures. The first impression is that the right fiber is the continuation of a fine process of the epithelioid cell next to it. On closer examination it is found however that the unmyelinated fiber is only adjacent to this cell and continues its course beyond. Photograph was retouched in order to bring out the finer details of the nerve endings ( $\times 1600$ ).

forming the thickened wall of the vessels however should be decisive in making the histological diagnosis.

While all authors agree that these tumors are arteriovenous anastomosis and hypertrophies of normal structures there is no agreement as to the significance of the nerve fibers and their endings. Alvarez Cascos and Costero look upon the tumor as of vascular and epithelial origin. They do not believe that the nerve elements form an integral part of the tumor tissue but assume that they are normal nerve fibers which only accidentally have been entangled with the tumor. On the other hand the presence of nerve fibers and endings in the form of bulbs and fine meshworks in our own tumor is in line with the assumption of Masson and others that the nervous elements form an integral part of the tumor which has to be considered as a unit of vascular and nervous elements.

Such an assumption will dominate our conception of the physiological function of the normal glomus. Its significance is somewhat

obscure. From its structure it is apparent that it has something to do with the circulation of the part. Sucquet has suggested that it maintains a constant capillary pressure while Hoyer and Bouceret believe that it acts in the maintenance of a constant local temperature a conclusion which is suggested by the fact that Grosser was unable to find these structures in reptiles. Grosser suggested that the glomus under the control of the pacinian corpuscles regulated the interstitial pressure a view to which von Schumacher subscribed. Masson also felt that the close relationship of the pacinian corpuscles was of significance and that they exerted a controlling action over the glomus.

Whether or not there exists any functional relationship between the digital glomera and the glomus coccygeus certainly a morphological similarity exists and Masson notes that the tumors which reproduce most nearly the structure of the coccygeal glomus are not those of the coccygeal glomus itself but those of the digital glomus.



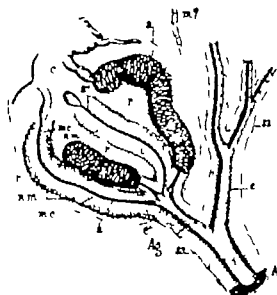


Fig. 7. Schematic reconstruction of a subcutaneous glomus. The dermal artery *A* gives off an afferent glomus artery, *A'*, which immediately divides into four neuro-muscular arterioles. The cutis, *c'*, of the afferent arteriole disappears as soon as the arteriole enters the glomus, at which point the lumen becomes narrower, while the walls become thicker, due to an increase in smooth muscle fibers, *sm*. The endothelial cells lining the vessels become apparently more numerous and ovoid or even cuboid in shape. Outside the layer of smooth muscle fibers, *sm*, lies a neuro-muscular layer, *sm*, containing peculiar smooth muscle cells poor in fibrils, and other cells without fibrils. Within this layer is found a network of unmyelinated nerve fibers with which in *Misson's* opinion many of the cellular processes from the neuro-muscular layer are in direct continuity thus indicating that certain of the neuro-muscular cells are in reality ganglion cells. An hypothetical connection exists between myelinated, *rv*, fibers, *M'*, and the perivascular network. Afferent capillaries (*c*), leave the glomus vessels to enter the skin vessels. The arteriole, *a*, with its rich perivascular network has a marked resemblance to the organ of Ruffini. (Copy from *P. Misson, Le glomus neuro-myo-artériel des régions tactiles et ses tumeurs* Lyon chir. 924, xvi, 257 Figure 6.)

The definite physiological effects of these tumors is well illustrated in the case of Paulian Stefan Popescu and Marinenco-Slatina. There was a small subungual tumor of the right middle finger which was associated with the typical painful crises but besides this there were increased feeling of warmth and increased perspiration over the whole right side of the body. Measurements of local temperature of the hand and forearm on each side showed an increase of from 0.5 to 2 degrees centigrade of the affected side over the normal side. These variations disappeared following opera-

tion. André's case showed muscular atrophy of the thigh, increased knee jerk on the involved side, some slight lessening of cutaneous sensibility and lowering of the local temperature.

In this connection it should be emphasized that in our case compression of the tumor or in other words emptying of the blood vessels was immediately followed by the disappearance of the feeling of intense pain. Refilling of the vessels, indicated by the reappearance of the bluish color of the tumor brought back again the painful sensation. Such observations suggested the idea that the pressure exerted by the extended blood vessels upon the nervous end-organs described was not conceived centrally as pressure but was perverted into a sensation of pain penetrating through the threshold of the normally sub-conscious level of such stimuli. No pain corpuscles or other end-organs could be detected in the immediate environment of the tumor—the subcutaneous tissue which had been removed during the operation. This led us to the hypothesis that the sensation of pain originated within the tumor itself and was not produced by a pressure of the enlarged blood vessels upon neighboring sensory end-organs.

The diagnosis of the glomus tumors should be easily made or at least suggested by a history such as has been outlined. It would not seem unlikely that with the recognition of this type of tumor many unexplained cases of neuralgia and causalgia will find an explanation as witness especially the instances recorded by Barré. Particularly of interest is the case in which the patient herself had noted no tumor and was even unaware of a very definite trigger zone which set off the painful crises. In instances of the definite cutaneous tumors in which the pain is known to arise the diagnosis should be made at least tentatively if the condition of glomus tumor is kept in mind.

The subungual tumors and other subungual conditions which may be confused seldom if ever present the painful crises or exquisite tenderness which characterize glomus tumors. The acute or chronic infections would seldom come into consideration. The subungual hematoma with a definite history of trauma

and acute onset does not present the painful paroxysms, while the pain which is present is distinctly worse on the first day and then gradually but surely diminishes. The diffuse coloration of a large area of subungual tissues and the gradual changes in the color along with the fact that the blood slowly approaches the tip of the finger as the nail grows are sufficient to distinguish this condition from glomus tumor. A glomus tumor may follow a crushing injury to the finger tip but if it does the pain and hemorrhage from the original trauma have usually disappeared before the symptoms start, and the symptoms have usually been present for a long time before the tumor becomes visible. Once the tumor is visible the discoloration remains at the same spot of the nail bed and does not migrate with the growth of the nail.

Dupuytren's exostosis produces a bony subungual tumor usually of the great toe which displaces the nail. It causes pain but does not lead to the typical paroxysms of glomus tumor. An X ray examination will of course show the exostosis. The X ray in case of a glomus tumor will frequently reveal a small shallow depression in the distal phalanx.

The subungual fibroma again does not cause paroxysms. The subungual epithelioma and melanoma may also come into consideration, both of these however lead to ulcerative lesions without again the typical crises of pain.

The subungual angiosarcoma reported by Kolaczek and Kraske and later by Carstensen we believe as does Hopf is really the glomus tumor. The clinical history of the angiosarcoma is identical with that of glomus tumor and the histological descriptions which have been published would certainly coincide with certain varieties of the angioneuromyoma of Masson.

The treatment of the glomus tumor is simple excision of the tumor mass. No known medical treatment has any lasting effect upon the pains. Temporary relief may be obtained in case of the subungual tumor by cutting a wedge shaped section from the nail over the tumor or by scraping or shaving off the nail over the tumor. The pain however, returns as the nail again grows over the tumor mass.



Fig. 8 Drawing of a section through a normal subcutaneous glomus stained with the triple stain. The section is through the first bifurcation of the afferent artery. *Ag* indicating the first two branches. *a*, indicates the disappearing internal elastic membrane of the afferent artery. *a'*, *a''*, and *a'''* indicate an apparent subdivision into small lobules, each of which corresponds to a distorted and not ramified glomus artery. *ce*, Epithelioid cell. *un*, myelinated perivascular network. *c*, Efferent capillaries. *m*, myelinated nerve fibers. *s*, sweat glands. *e*, cutaneous collagenous fibers. (Copy from the same article as in Figure 7—Figure 8 of Masson's publication.)

The tumor can be removed under a local anesthetic though it has been noted (Barré) that the tumor is difficult to anesthetize and manipulations during removal may occasion great pain. In a few instances the terminal phalanx has been amputated to remove the subungual tumor under the impression that a sarcoma was present. However since in no instance has a glomus tumor been known to metastasize or to recur after complete removal this radical procedure is not necessary. Some slight deformity of the nail may result from the operation but this is not a serious compli-

cation and is more than compensated for by the immediate relief of symptoms.

### PROGNOSIS

In the 34 cases upon which this report is based simple local removal was practiced in 24 and amputation of the finger or distal phalanx in 3. In 5 cases the nature of treatment is not known though it was probably local excision. In one case no treatment was instituted. Twenty-seven of the cases have been followed for a longer or shorter time. In all but one relief of symptoms was immediate and in none has a recurrence been reported. In one instance (Lortat Jacob) the finger was still painful but it was only a short time after operation and there has been no further report of the outcome in this case.

### SUMMARY AND CONCLUSIONS

A small subcutaneous tumor of the knee has been described which developed 37 years previously following an accident. Ever since the onset this tumor was extremely sensitive and tender as well as spontaneously painful. Following extirpation of the tumor these sensations disappeared completely.

Microscopically the tumor was recognized as a hyperplastic glomus similar in its structure to the tumors of the neuromyo-arterial glomus which had been first described by Masson in 1924.

### BIBLIOGRAPHY

- ADAM, FRANK E. PACK, G. T. and NICHOLSON, M. E. *Melanomas sous-unguésaux et leur diagnostic différentiel* propos de quatre cas. *Bull. de l'Ass. franç. p. l'étude du cancer* 1930, xix, 540-566.
- ALVAREZ CARLOS, M. and CORTIJO, J. Clinical and histopathological study on the so called subungual glomus tumors. *Arch. españ. Oncol.* 1932, II, 39.
- A. and THOMAS. Tumeurs comparables à des tumeurs glomiques des doigts dans les crânes de la culasse à la suite d'un traumatisme. *Ann. d'anat. path.* 1934, x, 653-666.
- ARON, M. C. Nodule sous-cutané à structure de neuromy-arteriel leiomyxomatueux. *Bull. Soc. franç. de dermat. et syph.* 1931, xxxviii, 222.
- BARRE, J. A. Sur certaines sympathalgies de la périphérie des membres. Leur traitement chirurgical simple. *Paris méd.* 1922, xli, 3, 15.
- BARRE, J. A. and MASSON, P. Etude anatomique-clinique de certaines tumeurs sous-unguésales douloureuses (tumeurs du glomus neuro-myo-arteriel des extrémités). *Bull. Soc. franç. de dermat. et syph.* 1924, xxxi, R. S. 48.

7. BENOIST, P. Tumeur sous-unguésale douloureuse; tumeur du glomus neuromyo-arteriel. *Lyon chir.* 1927, xxiv, 718-721.
8. CAISTERBERG, J. Ueber subunguale Tumoren. *Arch. f. klin. Chir.* 1927, cxlvii, 400-431.
9. CHAMBERLAIN, A. Recherches histologiques sur les tumeurs sous-cutanées douloureuses. *Arch. de physiol. norm. et path. Par.*, 1882, 2, 3, ix, 630-683.
10. DA COSTA, J. C. *Modern Surgery* 1915 9th ed. 200-300.
11. DUPONT, A. Aspects atypiques des tumeurs glomiques. *Rev. belge sc. méd.* 1931, III, 624-630.
12. GIBBO, D. M. Subcutaneous glomus tumours: painful subcutaneous nodules. *Edinburgh M. J.* 1928, xxxv, 555-582.
13. GROSSER, O. Ueber arterio-venöse Anomalien an den Extremitätenenden beim Menschen und die krallentragenden Saecogitherra. *Arch. f. mikr. Anat.* 1903, ix, 191-206.
14. HOER, M. Ueber Tumoren des neuromyoarteriellen Glomus (Masson). *Frankfurt Ztschr. f. Path.* 1930, xl, 587-599.
15. JAKSCHKEWITZ, A. and LEBEL, M. Une variété de Neuralgie la sympathalgie due à une tumeur glomique. *Presse méd.*, 1928, xxxvi, 6-118.
16. KOLACZEK, J. Ueber das Angio-Sarkom. *Deutsche Ztschr. f. Chir.* 1878, ix, 148, 165-227.
17. KRASSKE, P. Ueber subunguale Geschwülste. *München med. Wochenschr.* 1887, xxxiv, 689-691.
18. KROEMER, S. Histologische und entwicklungs-geschichtliche Untersuchungen ueber das Glomus coccygium des Menschen. *Verhandl. d. anat. Gesellsch.* 1932, xli, 176-185.
19. LORTAT JACOB, L. and BROUET, T. Tumeur sous-unguésale violacée et douloureuse avec canal de membre supérieur (glomus tumoral neuro-myo-arteriel). *Bull. Soc. franç. de dermat. et syph.* 1924, xxxv, 305-309 361.
20. LOUCHET, M. Tumeurs sous-unguésales douloureuses (angio-myo-neurones artériels) tumeurs glomiques. Thèse de Lyon, 1927.
21. MARTIN, J. F. and DUCHAUME, J. Les Tumeurs Glomiques. *Ann. d'anat. path. med-chir.* 1915, II, 230-246.
22. MASSON, P. Le Glomus neuromyo-arteriel des régions tertiaires et ses tumeurs. *Lyon chir.* 1924, xli, 257-280.
23. MASSON, P. and GIBBO, L. Les tumeurs glomiques sous-cutanées en dehors des doigts (angio-neurones artériels). *Ann. d'anat. path.*, 1927, iv, 53-65.
24. NICCO, J. L. Le Glomus neuromyo-arteriel sous-cutané et ses tumeurs. *Schweiz. med. Wochenschr.* 1927, vB, 1177-1179.
25. PAULIAN, D., STEFAN PAPERCU and MARINICU-SLATINA, D. Tumeur glomique sous-cutanée suivie d'hémiparésie et de réaction compliquée après l'ablation chirurgicale. *Ann. d'anat. path.* 1933, x, 271-276.
26. PICARD, H. Ueber seitliche Tumoren am Nagelbett (Neuromyoarterielle Glomustumoren). *Zentralbl. f. Chir.*, 1931, lviii, 2133-2135.
27. SAWADA, H. Subcutaneous cavernous angiomyofibroma. *Acta Dermatol.*, 1930, xvi, 568-574.
28. VON SCHUMACHER, S. Ueber das Glomus coccygium des Menschen. *Arch. f. mikr. Anat.* 1907, lxxi, 58.
29. VINCENT, J. Des tumeurs sous-unguésales douloureuses. Thèse de Lyon, 1900.

EXPERIMENTAL STUDIES OF REPARATIVE COSTAL CHONDROGENESIS AND OF TRANSPLANTED BONE<sup>1</sup>

J DEWEY BISGARD M.D., OMAHA, NEBRASKA

THE constant failure (in a series of 19 cases) of dechondralized portions of the thoracic wall to regain normal pre-operative skeletal rigidity led to an investigation of reparative costal chondrogenesis. From this investigation it was apparent that the costal perichondrium has relatively slight chondrogenetic function and that skeletal rigidity after resection of cartilages can be obtained only by artificial means such as the engrafting of bone.

In the 19 patients observed clinically costal cartilages had been resected from 6 months to 2 years previously.

1 In 8 cases they were resected to gain the maximum collapse of the thoracic wall from thoracoplasty necessary to close the very large tuberculous pulmonary cavities. This degree of collapse was obtainable only by the resection of all skeletal tissue sheltering these cavities, and this included total resection of the upper three or four costal cartilages and in two instances a portion of the sternum as well as the ribs overlying the cavities. In each instance a wide posterolateral thoracoplasty was supplemented by the anterolateral operation described by Alexander<sup>2</sup> in his treatise on the problem of closure of these very large cavities.

2 In 4 cases costal cartilages were removed to gain an exposure of the heart and mediastinum.

3 In 5 cases resections were done to eradicate tuberculous or pyogenic chondritis.

4. Massive resections were done in 2 cases with neoplasms involving the cartilages.

In all of these cases the failure of the anterior wall to regain rigidity not only permanently deprives the underlying viscera of skeletal protection but also permanently permits paradoxical motion of the dechondralized area. If paradoxical respiration occurs over a large surface as it did in one case (extensive resection of a neoplasm) a moderate degree of cardiorespiratory embarrassment ensues. The pliable anterior wall after anterolateral thoracoplasty also complicates collapse therapy. It makes it impossible to maintain the desired compression of the underlying cavernous lung

without applying pressure (probably indefinitely) by means of an especially constructed brace and pressure pad.

## EXPERIMENTAL OBSERVATIONS

To investigate the cause of failure of the dechondralized portions of the thoracic wall to regain skeletal rigidity and to obtain a method by which it could be restored, a group of experiments was carried out on 6 dogs. Since each dog was the subject of two or more experiments a logical presentation of the investigation makes it necessary to discuss the individual experiments in group sequence followed by protocols of procedures carried out in each animal.

In all experiments total costal cartilages were resected subperichondrially and the perichondrial flaps were sutured together to reconstruct a tube which was either left empty or contained periosteal osteoperiosteal or simple osseous grafts. The animals were killed at various intervals and the anterior half of the thorax was removed *en masse* for roentgenological and for gross and microscopic study.

*Experiment 1 Simple dechondralisation.* In each of 3 adult dogs one entire costal cartilage was resected subperichondrially and cancellous bone of both the sternum and the rib was exposed. Empty perichondrial tubes were reconstructed with a few interrupted sutures. The wounds healed by first intention and throughout the period of observation there remained slight depressions corresponding to the areas from which the cartilages had been removed. These depressions moved paradoxically to a slight extent with respiration and did not offer the normal resistance of cartilage to pressure.

The animals were killed 44, 93 and 112 days after operation and the anterior thoracic walls were removed for study. In no specimen was there palpable evidence of regenerated cartilage. Extending from the bulbous end of the rib to the sternum there was a ribbon of very pliable dense fibrous tissue measuring 2 to 3 millimeters in thickness. In the roentgenograms as illustrated in Figure 4, 2 this tissue cast a shadow of no greater density than soft tissue. Microscopically throughout its entire extent the tissue consisted of a layer of fairly dense fibrous tissue

Alexander, John. Special considerations relating to surgical closure of large upper lobe tuberculous cavities. *J. Thoracic Surg.*, 1933, 4, 3.

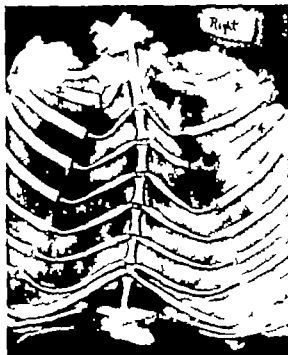


Fig. 1. Dog 90G. Postmortem roentgenogram of the anterior half of the thoracic wall, 90 days after operation. (1) The second right cartilage and adjoining 6 centimeter segment of the rib were resected. Note absence of a shadow of greater density than soft tissue. (2) Second left cartilage resected and replaced by small segmental costal transplants without periosteum. Note complete fusion of individual grafts and fusion of the grafts with the sternum. The union between rib and grafts casts a shadow of less density. (3) Fourth right cartilage and adjoining 6 centimeter segment of rib were resected; cartilage replaced by small costal grafts devoid of periosteum. Individual grafts have fused together and with the sternum; rib incompletely regenerated.

approximately three or four times thicker than normal perichondrium. Interspersed at widely separated intervals, as illustrated in Figure 2, there were small nests of cartilage cells giving rise to very small areas of newly formed fibrocartilage. New bone arising from the end of the rib had invaded the perichondrial tube for a very short distance only. If at all, and that arising from the sternum had merely sealed the cancellous spaces which had been opened at operation.

**Experiment 2. Resection of cartilage and adjoining segment of rib.** This experiment was performed upon 3 dogs and in addition to total resection of cartilages approximately 5 centimeters of each adjoining rib was excised. Empty perichondrial tubes were reconstructed after the cancellous bone of the sternum was laid bare. Specimens were obtained for examination 101 days after operation. In each instance there was roentgenological (Fig. 1) gross, and microscopic evidence that the rib had regenerated



Fig. 2. A low-power photomicrograph of a perichondrial bed 101 days after resection of cartilage. The perichondrium is much thicker than normal and is made up of a wide band of fairly dense fibrous tissue containing (at C) a small island of fibrocartilage.

partially up to, but apparently not beyond, the pericostoperichondrial junction. The perichondrial tubes had become bands of dense fibrous tissue containing only a few small islands of fibrocartilage.

In each of the five experiments (Experiments 1 and 2) there was failure of the costal cartilages to regenerate after complete subperichondrial resection. Repair was effected almost entirely by dense fibrous tissue. The few minute nodules of fibrocartilage gave no rigidity to the tissue. New bone proliferating from the rib and sternum did not invade the perichondrial tube. The tissue was no less pliable than a strip of fascia lata.

**Experiment 3. Periosteal (pedicle) grafts.** In 3 dogs costal cartilages were resected and cancellous bone at both the sternal and costal extremities of the bed was exposed. A flap of periosteum was raised from the external surface of the adjoining rib in each instance and was turned upon a pedicle into the perichondrial bed. The free end was anchored to the periosteum of the sternum and the edges of the perichondrium were approximated to form a tube enclosing the graft. Nutrient pedicles were preserved to give to the grafts the most favorable circumstances for viability and osteogenesis. The wounds healed *per primam* and the animals were killed and the specimens obtained for examination 93 and 106 days after operation.

Roentgenologically (Figs. 3, 1 and 4, 1) and morphologically in the gross, the specimens were identical to those described in Experiment 1 and differed in microscopic appearance only by the presence of a very few scattered trabeculae of newly formed bone in both specimens. This new bone was undergoing absorption.

Although the perichondrial tubes contained a few islands of fibrocartilage and very occasionally a few trabeculae of bone the tissue had no skeletal rigidity and was as pliable as the specimens obtained in Experiments 1 and 2

**Experiment 4 Costal osteoperiosteal grafts** This experiment was carried out in 3 dogs. As in the previous experiments costal cartilages were resected subperichondrially and cancellous bone of the sternum was exposed. From the anterior end of a rib a segment of approximately 6 centimeters was removed with the periosteum attached to its external surface. It was bisected longitudinally and each half was then cut into several small segments which were placed as grafts in the perichondrial bed in a continuous chain contacting each other and the cancellous bone of the sternum and of the rib. In two animals the segment used for grafts was obtained from a rib of the opposite side and in one from the anterior end of the dechondralized rib. The edges of the incised perichondrium were approximated to secure the grafts firmly in place. The wounds healed *per primam*.

The specimens were obtained for examination at necropsy 44, 93 and 112 days after operation. The roentgenograms of each specimen showed a continuous shadow of the density of bone uniting the rib to the sternum (Fig 4 3). The grafts had become amalgamated so completely that they did not cast individual shadows. To inspection and palpation a continuous, hard, inelastic, irregularly nodular plaque of bone firmly united the rib to the sternum, and gave solid skeletal rigidity to each perichondrial tube.

Sections were cut through the long axis of each specimen including the sternum and the anterior end of the rib. With low power magnification (Fig 5) the individual grafts were readily discernible. They were firmly united to each other and to the sternum and costal stump by newly formed compact bone which in most instances formed a continuous cortex and bridged the medullary canals. Union in a few instances consisted of osteoid tissue which was only partially ossified. In general the unions between the grafts and the sternum and the grafts and the rib were firmer than those between the individual grafts. All grafts, as illustrated in Figure 6 contained some dead bone but consisted principally of new bone which had replaced the dead bone extensively. Some cancellous spaces contained vascular fibrous tissue and others only cellular marrow. Both osteoclasts and enchondral osteogenesis were in progress in large areas both within the grafts and at the sites of fusion. The resected costal segments had regenerated completely and in the one experiment with grafts taken from the costal stump the regenerated segment had established solid bony union with the fused grafts.

**Experiment 5 Costal osseous grafts without periosteum.** This experiment was repeated five times in 3

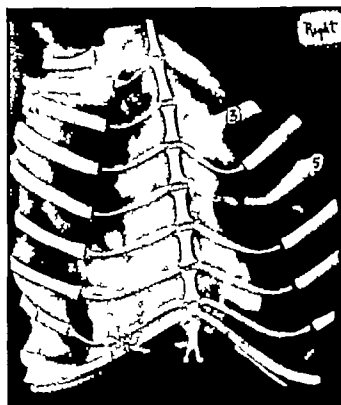


Fig 3 Dog 72G Postmortem roentgenogram. (1) Third right cartilage was resected and a periosteal flap raised from the external surface of the rib and turned and sutured into the perichondrial bed. Note that the density is no greater than that of soft tissue. (2) Fifth right cartilage and adjoining segment of rib were resected. Grafts from the latter devoid of periosteum, have fused with the sternum but have incompletely fused with each other and with the regenerated rib.

dogs. It represents a repetition of Experiment 4 with the exception that bone devoid of periosteum was used for the grafts. These grafts not only were resected subperiosteally but also were scraped vigorously to assure complete removal of the cambium layer. They were obtained from the anterior end of the adjoining rib for three of the experiments and from ribs of the opposite side for the 2 others. At necropsy 101, 101 and 108 days after operation the specimens were removed for examination. To palpation and upon section the grafted perichondrial beds were made up of irregularly nodular, continuous cylinders of bone which rigidly united each costal stump to the sternum.

In roentgenograms of three of the five grafted beds the macroscopic evidence of complete continuity of bone was not verified (Figs. 1 2 3- and 3 2). Some grafts were identifiable as distinct isolated segments while others had fused and lost individual distinction. In each instance the union between the sternum and grafts cast shadows of the density of bone but that between the grafts and the costal stumps or regenerated ribs lacked bony density.

Microscopically, however there was in each specimen unbroken continuity through osteoid tissue and

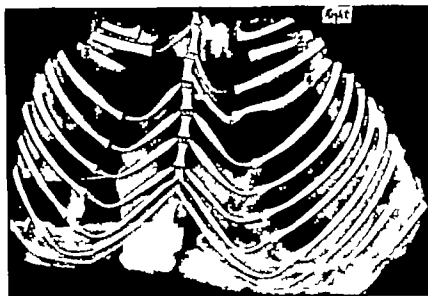


Fig. 4 Dog 75G. Postmortem roentgenogram. (1) Second right cartilage was resected and a pedicled graft of perichondrium was resected from the external surface of the rib and sutured into the perichondrial bed. Its shadow is of no greater density than that of soft tissue. (2) Third left cartilage was resected and an empty perichondrial tube was reconstructed. Not only soft tissue density. (3) Fourth right cartilage and 6 centimeter segment of rib were resected with a strip of perichondrium adherent to the external surface; this was split longitudinally and cut into small segments and used as osteoperiosteal grafts with sternum and regenerated rib. Note complete fusion of all grafts and of

newly formed trabeculae of bone between all individual grafts and between the grafts and the sternum and the grafts and the rib. All grafts contained both old dead and newly formed bone. This process of absorption of the dead transplants and replacement by new bone had progressed very extensively in some segments and in others only moderately. Between grafts osteogenesis appeared to be very active and was found to be principally enchondral in type. There was both fibrous and cellular marrow.

These transplants devoid of periosteum showed distinctly less absorption and less replacement by new bone than did the osteo-

periosteal grafts of Experiment 4. Also, fusion of the grafts to each other and to the costal stumps had progressed to a lesser



Fig. 5 Low power photomicrograph of a longitudinal section of the osteoperiosteal grafts (Fig. 4, 3) showing solid bony fusion of grafts A and B at C and fusion of graft A with the sternum S at D.



Fig. 6 A high-power photomicrograph of a section of an osteoperiosteal graft shown in Figure 5. Note extensive replacement of the old dead bone A of the graft by newly formed bone B by the process of creeping substitution.

degree, the union in a few instances being effected only by sparsely ossified osteoid tissue

#### THE PROTOCOLS

1 *Dog 70G* (Fig 1) Adult mongrel, weight 17.6 kilograms. Operation December 29, 1932 ether anesthesia necropsy April 11, 1933

Experiment 2 Resection of the second right costal cartilage and adjoining segment of rib

Experiment 5 Resection of the second left cartilage with grafts of bone without periosteum.

Experiment 5 Resection of the fourth right cartilage and adjoining segment of rib grafts of bone without periosteum.

2 *Dog 71G* Adult mongrel fox terrier weight 12 kilograms. Operation December 29, 1932 ether anesthesia necropsy April 11, 1933

Experiments 2, 5 and 5 carried out as those in *Dog 70G*

3 *Dog 72G* (Fig 3) Adult mongrel bulldog weight 14.2 kilograms. Operation December 20, 1932 ether anesthesia necropsy April 7, 1933

Experiment 3 Resection of the third right cartilage and its replacement by periosteal (pedicle) graft.

Experiment 5 Resection of the fifth right cartilage and adjoining segment of the fifth rib free grafts of bone without periosteum.

4 *Dog 73G* (Fig 4) Adult mongrel weight 14.6 kilograms. Operation January 3, 1933 ether anesthesia necropsy April 7, 1933

Experiment 1 Resection of the third left cartilage.

Experiment 3 Resection of the second right cartilage pedicle graft of flap of the periosteum.

Experiment 4 Resection of the fourth right cartilage and free osteoperiosteal grafts from adjoining segment of the fourth rib

5 *Dog 16N* Adult spitz, weight 17 kilograms. Operation September 15, 1932 ether anesthesia necropsy January 7, 1933

Experiment 1 Resection of second right cartilage.

Experiment 4 Resection of third left cartilage and free osteoperiosteal grafts.

6 *Dog 17N* Adult mongrel, weight 12.5 kilograms. Operation September 21, 1932 ether anesthesia necropsy November 5, 1932

Experiments 1 and 4 Carried out precisely as in *Dog 16N*

#### DEDUCTION FROM STUDY

Constantly in the dog as in man there is failure of the cartilaginous portion of the thoracic wall to regain skeletal rigidity after costal chondrectomy. The cause of this failure was investigated in animals because human material was not available for histological study. In each of 5 dogs one costal cartilage was re-



Fig. 7 An oblique roentgenogram of the left hemithorax of a man 21 years of age. Four months previously the left third costal cartilage which contained a benign cartilaginous tumor the size of an English walnut was resected sub-perichondrially. A segment of the costal stump 5 centimeters long was removed, split longitudinally and the two pieces were placed in the dechondralized perichondrial bed so that the space was completely spanned with engrafted bone. Contact was made with the exposed cancellous bone of the sternum.

In this roentgenogram note that a plaque of new bone has established bony union with the regenerated segment of the third rib and (probably) fibrous union with the sternum. The line indicated by S between the sternum and the newly formed bone is interpreted as evidence of a pseudoarthrosis.

Clinically this area has firm skeletal rigidity

sected and the perichondrial tube was reconstructed. At the termination of the experiment these tubes had become ribbons of normally pliable fibrous tissue with no palpable evidence of skeletal tissue. However a study of numerous histological sections (cut both longitudinally and transversely) demonstrated the presence of a few small islands of fibrocartilage within the thick layer of fairly dense fibrous tissue. Obviously chondrogenesis had



played an almost negligible part in the reparative process. There was also no evidence of invasion of the perichondrial tubes by the proliferating new bone at the sternal and costal ends. In animals in which a segment of the anterior end of the rib had been excised with the cartilage regeneration of the rib was complete but proliferation of bone did not extend beyond the periosteal-perichondrial junction.

In an endeavor to develop a method which would give the desired skeletal rigidity to the dechondralized perichondrium three types of grafts were given experimental trial. Pedicled grafts of the costal periosteum were used and these gave rise to only minute deposits of osteoid tissue and new bone, apparently too meager in amount to contribute any rigidity which could be demonstrated upon gross examination.

Segmental grafts of bone cut from ribs and enclosed within perichondrial tubes fused forming continuous rigid plaques of bone which in each instance united the rib to the sternum and gave skeletal rigidity to the thoracic wall. Grafts with and without periosteum were used. Distinctly more new bone and firmer fusions developed from the osteoperiosteal grafts.

To the author's knowledge this method of gaining skeletal rigidity by replacement of costal cartilages with small segments of bone has never been used clinically. But upon the basis of the experimental data here presented clinical trial in non infected cases seems justifiable. The placement of costal grafts in a freshly dechondralized bed is a relatively simple procedure and would add very little to operations involving resection of cartilages.

# CONCLUSIONS

- 1 The costal perichondrium of both man and dog has very slight or no reparative chondrogenetic function. Supportive evidence from clinical observations and experimental studies is presented.

- 2 New bone arising from the sternum and from the end of the rib did not proliferate for an appreciable distance beyond the periosteal-perichondrial junction. Proliferation from the regenerating segments also did not progress beyond this point.

- 3 In the dog costal grafts to the perichondrial bed become necrotic (either totally or partially) absorb and are replaced by new bone. If placed in apposition fusion takes place between the individual grafts, the grafts and the sternum and the grafts and the anterior stump of the rib. By this means a dechondralized segment of the thoracic wall can be given skeletal rigidity. The best results were obtained with osteoperiosteal grafts.

- 4 Upon the basis of the experimental data herein reported clinical trial of immediate transplantation of osteoperiosteal grafts to suitable chondrectomized perichondrial beds is recommended.

NOTE.—Since this article was submitted for publication the principle herein investigated has been given clinical trial in 5 cases by Dr. John Alexander and Dr. Cameron Haight of the University of Michigan and in one case by the author.

In Alexander's and Haight's cases, the costal bony transplants replaced cartilages which had been resected in order to collapse the anterolateral thoracic walls over large tuberculous cavities. A recent communication from Dr. Haight states that skeletal rigidity has developed in 3 of the first 3 patients operated upon.

A brief report of the author's case has been appended with an illustrative roentgenogram, Figure 7.

## THE ELIMINATION OF MORPHINE AND QUININE IN HUMAN MILK

WILLIAM G. TERWILLIGER, M.D. AND ROBERT A. HATCHER, M.D., New York  
From the Women's Clinic of the New York Hospital and the Department of Pharmacology of Cornell University Medical College

THE extent to which therapeutic agents or poisons administered to the nursing mother are excreted in the milk has not been the subject of exhaustive investigation, and while our knowledge of the subject is meager, physicians are prone to attribute unexplained illness of the nursing child to any poison which may have been administered to the mother. We planned an extensive study of the elimination of various alkaloids in the milk of women, but circumstances beyond our control have interrupted the studies and we will report here the results obtained with only two substances—morphine and quinine, one of us having previously studied the elimination of nicotine in milk (4). We began a study of the elimination of caffeine and expect to continue that investigation in the not distant future.

Joachimovits stated that only occasional investigations have been made of the excretion of drugs in milk owing partly to the difficulties involved. Reed stated that the elimination of drugs in the milk is unusually obscure, many of the investigations being quite valueless. He presented a bibliography of about 150 references. Evans reported the death of an infant following the administration of 180 minims of Battley's sedative to the mother during about 30 hours previous to nursing. The child probably died from opium poisoning but the case is reported in insufficient detail to permit of an accurate analysis, and there is no satisfactory evidence that the infant obtained the poison through the milk. Thiemich, whose paper is frequently quoted, performed no experiments but reviewed the literature. He gives 59 references. Bucura stated that extremely few drugs have been found in the milk with certainty. He administered tincture of opium, codeine, and quinine to women, and stated that Professor Panzer was unable to obtain any of these substances from the milk. Talbot stated that morphine had not yet been found in human

milk. Joachimovits stated that traces of various substances fluoresce in human milk (quinine 1:40,000,000), which may be observed in the filtered ultraviolet light by means of the Hanauer analytical lamp.

Many of the alkaloids may be recovered almost quantitatively from milk when small amounts are present, and this fact influenced our choice of substances for the first series of our studies.

The method used, with slight modifications is as follows: the milk is rendered alkaline by the addition of sodium hydrate (not for morphine) or bicarbonate of sodium, it is shaken with from 10 to 20 times its volume of chloroform previously deprived of alcohol (except for morphine), the nearly clear chloroform which separates after standing a few minutes is filtered, the filtrate is distilled, the residue is treated with a little dilute acid, this is separated, rendered slightly alkaline with bicarbonate of sodium, and shaken with chloroform, the chloroformic extract is filtered, the filtrate is evaporated, the residue is weighed and the amount of alkaloid in the residue is determined in one of several ways. Small amounts of quinine—fractions of a milligram—may be estimated by determining the dilution which affords a reaction with Valser's reagent (9) (a modified form of Mayer's reagent) equal to that induced by one part of quinine base in 1,500,000 of solution. Morphine may be estimated colorimetrically by means of Marquis's reagent (3).

### CONTROL EXPERIMENTS

Control experiments with cow's milk indicate that the greater part of 0.1 milligram of quinine base may be recovered after adding it to 250,000 parts (25 cubic centimeters) of milk, that about 40 per cent can be recovered after the addition of 0.1 milligram to 1,000,000 parts (100 cubic centimeters) of milk, and that it can be detected in even greater dilutions. Morphine may be recovered and iden-

tified in the purified extract after adding 4 milligrams of the base to 50 000 parts (200 cubic centimeters) of cow's milk. We report the actual amounts of alkaloid recovered in every case, but it is evident that the concentration in the milk was seldom sufficient to permit of an accurate quantitative estimation of that present but one may be certain in such cases that only negligible amounts of the alkaloid were present in the milk.

#### MORPHINE (IN HUMAN MILK AND URINE)

Mrs. M. M., an addict, who reported that she had taken 20 grains of morphine sulphate daily entered the Woman's Clinic on March 13 and from 8 10 p.m. of that date until 7 40 p.m. of the next day she received a total of 102 milligrams of morphine sulphate, the last injection of 32 milligrams being made a few minutes before delivery but these doses were ineffective. She was delivered of a normal female baby weighing 3,380 grams. She continued to receive 128 milligrams of morphine sulphate daily and the baby was put to the breast at 10 o'clock, and again at 2 o'clock, the day after birth.

In the meantime the infant was irritable and cried much of the time. It was restless, yawned frequently, had snuffles, the body became rigid and the condition became worse until the morning of the 17th (about 60 hours after birth) at which time the infant was transferred to the department of pediatrics. The foregoing signs were interpreted as those of addiction, especially since they disappeared when the infant received small doses of morphine, later of tincture of opium. This is of especial interest in view of the part that psychic influences are commonly supposed to play in the mechanism of addiction, since such psychic influences are evidently absent in the newborn. The infant continued to receive tincture of opium until it was discharged in good condition, 49 days after birth, at which time it weighed 4,420 grams, a gain of 1,040 grams.

A specimen of milk measuring 11 cubic centimeters was withdrawn on March 17 at which time the woman was receiving 128 milligrams of morphine sulphate daily by hypodermic injection. The milk was extracted with chloroform which contained 4 per cent of alcohol by volume, the purified residue, which weighed 1 milligram, did not afford a trace of purple color with a few drops of Marquis's reagent, indicating that the milk contained not more than a trace of morphine. A similar result was obtained from a total of 41 cubic centimeters of milk withdrawn at various times on March 19.

A specimen of urine measuring 73 cubic centimeters was received at the same time. This contained rather less than  $\frac{1}{4}$  milligram of morphine. A specimen of urine collected on March 19 contained only a trace of morphine, but 375 cubic centimeters, obtained March 20 contained about 3 milligrams.

Mrs. D. received 16 milligrams of morphine sulphate hypodermatically at 10 30 p.m., April 17. A specimen of milk measuring 75 cubic centimeters was withdrawn the next morning after an interval of 7½ hours. Of this 13 cubic centimeters was extracted in the usual manner. The purified residue gave a questionable reaction with Marquis's reagent, but it contained not more than a trace of morphine, if any.

#### QUININE (IN HUMAN MILK)

Mrs. L. C. received 300 milligrams of quinine sulphate orally at 2 00 p.m. on April 4, shortly after the breasts had been emptied. At 5 00 p.m., 4 cubic centimeters of milk was drawn. It yielded a trace of quinine, the concentration being of the order of 1:400,000. The breasts were emptied on April 5 at 6 00 a.m. and a dose of 300 milligrams of quinine sulphate was given orally an hour later. At 10 00 a.m. a specimen of milk measuring 18 cubic centimeters was obtained. This yielded about 0.02 milligram quinine base, the concentration being approximately 1:500,000. She received 300 milligrams of quinine sulphate orally at 10 15 a.m. and a specimen of milk measuring 7 cubic centimeters was obtained 2 hours and 45 minutes later. It yielded about 0.016 milligram quinine base, the concentration being about 1:440,000. Fifteen cubic centimeters of milk was obtained at 4 00 p.m. 3 hours after the preceding. It contained about the same total amount of quinine, the concentration being about half that in the previous specimen. A specimen measuring 39 cubic centimeters was obtained at 6 00 p.m. on the following day, 31 hours and 45 minutes after the last dose of quinine. The extract yielded about 0.003 milligram quinine, which would indicate the concentration of 1:13,500,000 but since the method does not permit of the detection of quinine in milk in such low concentration, it is certain that it contained somewhat more quinine than that, though not more than a trace. A specimen measuring 15 cubic centimeters obtained 12 hours later, 43 hours and 45 minutes after the last dose, did not yield a trace of quinine.

Mrs. W., 3 months postpartum entered the Woman's Clinic on April 1 because of high blood pressure, which fell to normal with rest in bed. A specimen of 265 cubic centimeters of milk was obtained at 6 00 a.m. on April 7. One hundred cubic centimeters of this extracted for a control experiment, gave a negative result. Half an hour after withdrawing the specimen, the patient received 300 milligrams of quinine sulphate by the mouth. A specimen of milk measuring 97 cubic centimeters was obtained 3½ hours later. It yielded 0.037 milligram of quinine base. A few minutes after the breasts had been emptied, she received a second dose of 300 milligrams of quinine sulphate by the mouth, and after 2 hours and 45 minutes a specimen of milk measuring 226 cubic centimeters was withdrawn of this 100 cubic centimeters was extracted. This yielded about 0.09 milligram, corresponding to 0.2 milligram from

226 cubic centimeters of milk. A specimen measuring 73 cubic centimeters was withdrawn 3 hours later. It yielded 0.032 milligram quinine base. A specimen measuring 85 cubic centimeters which was withdrawn 8 hours and 45 minutes after the administration of the quinine, yielded 0.065 milligram quinine base. A specimen measuring 265 cubic centimeters, obtained 19 hours and 45 minutes after the administration of the quinine was bluish in color and obviously very poor milk. Not a trace of quinine could be detected in this or in another specimen, measuring 204 cubic centimeters, obtained 4 hours later.

Mrs. D. One specimen of milk was examined before the administration of quinine as a control the results did not indicate the presence of a trace of quinine. Ten specimens were examined after the administration of 640 milligrams of quinine sulphate by the mouth at 9:30 a.m. on April 14. The first after an interval of 30 minutes (and including that secreted before the drug was given) contained only a trace. The second measuring 53 cubic centimeters, drawn 3 hours after the first, yielded about 1/20 milligram of quinine. The third fourth and fifth, drawn after intervals of 6 1/4, 12 1/4 and 20 1/4 hours after the administration, still contained the merest traces and not a trace was found in specimens drawn after that. A second oral dose of 640 milligrams of quinine was administered at 8:30 a.m. on April 17. A specimen of milk, measuring 46 cubic centimeters, obtained 1 1/4 hours later yielded 0.05 milligram quinine base. A second specimen measuring 36 cubic centimeters, obtained 3 hours later contained quinine in much lower concentration and a specimen measuring 75 cubic centimeters, obtained 21 1/4 hours after the second dose of quinine, did not yield a trace of quinine.

The results in this study indicate that the excretion of quinine in the milk reached its maximum about 90 minutes after the oral administration.

Mrs. I. M. Six specimens of milk, including one control, were examined. The patient received 640 milligrams of quinine sulphate orally at 10:15 a.m. on April 28. A specimen of 215 cubic centimeters of milk obtained 3 hours and 15 minutes later yielded about 0.02 milligram quinine. A second specimen of only 2 cubic centimeters obtained 6 hours after the administration of the quinine, was not enough for a satisfactory examination, but not a trace of quinine could be detected in it. A third specimen measuring 11 cubic centimeters obtained 19 hours and 45 minutes after the administration of quinine, yielded only a trace of quinine. At this time a second dose of 640 milligrams of quinine sulphate was given as before. A specimen of 11 cubic centimeters, which yielded 0.01 milligram of quinine base was obtained 3 1/4 hours later. Another specimen of 10 cubic centimeters, obtained 3 hours later yielded about 0.016 milligram. As the supply of

TABLE L—SUMMARY OF CASES

The volume of the milk withdrawn, the dose administered, the interval following before the milk was obtained and the amount of the drug recovered.

P. tent	Milk vol. c.c.m.	Dose in grains	Interval hrs. min.	Recovered in grains
MORPHINE				
M. M.	41	128		None
D.	13	6	70 30	Trace
QUININE				
L. C.	4	300	3	Trace
	7	300	3 45	0.06
	15		5 45	0.16
	30		31 45	Trace
	15		43 45	None
W.	97	300	3 30	0.037
	73	300	6 45	0.13
	85		8 45	0.05
	165		10 45	None
	204		3 45	None
D.	54	640	30	0.035
	13		3 30	0.033
	45		6 30	Trace
	93		10 30	Trace
	15		10 30	Trace
I. M.	46	640	4 30	None
	26		1 30	0.04
	26		4 30	0.01
	73		30	None
	8	640	3 15	0
E. S.	1		10 45	Trace
	1	640	3 30	1
	0		6 30	0.16
	16	640	6 30	0.006
	1		6 30	0.01
A.	28		18 30	Trace
	30		23	Trace
	27		26 5	None
	25	64	8	0.1
	80		1	0.01
	90	640		None
	28			0.3
			6	0.03

milk was poor the observations on this patient were discontinued.

Mrs. E. S. received 640 milligrams of quinine sulphate by the mouth at 11:30 a.m. on May 10 following a stillbirth. A specimen of milk measuring 26 cubic centimeters obtained 2 1/4 hours later yielded approximately 0.006 milligram quinine base. A second specimen, measuring 25 cubic centimeters obtained 4 hours later yielded about 0.01 milligram of quinine. A third specimen, measuring 28 cubic centimeters, obtained 12 hours later and one measuring 30 cubic centimeters, obtained 4 1/4 hours later 23 hours after the administration of quinine, contained only traces, and the last specimen measuring 27 cubic centimeters, obtained 26 1/4 hours after the administration did not yield a trace of quinine.

Mrs. A. was delivered in the seventh month because of a placenta praevia at which time 600 cubic

centimeters of blood was lost. The observations were started 5 days later. Seven specimens of milk were examined, including a control which was drawn before the quinine was given, and which was negative. The patient received 640 milligrams of quinine sulphate orally at 8:00 a.m. on May 29. The milk, measuring 55 cubic centimeters, obtained 2 hours later yielded about 0.01 milligram quinine base. Another specimen, measuring 21 cubic centimeters, obtained 4 hours later contained about the same amount, but not a trace of quinine could be detected in a specimen, measuring 80 cubic centimeters, obtained 22 hours after the administration of the quinine. A second dose of 640 milligrams of quinine sulphate was administered at 8:00 a.m. on May 31. The milk, measuring 90 cubic centimeters, was obtained 2 hours later and a second specimen measuring 28 cubic centimeters, was obtained 6 hours after the administration of the quinine. Each yielded about 0.03 milligram of quinine base.

#### SUMMARY

1 Morphine may be extracted from 50,000 parts of milk and identified with certainty.

2 A woman addicted to morphine gave birth to an apparently addicted but otherwise normal infant, which developed normally during the administration of small doses of morphine or opium during 49 days (and presumably after withdrawal).

3 Not a trace of morphine could be detected in the milk of a woman addicted to morphine.

4 A specimen of milk drawn from a normal woman 7 hours and 30 minutes after the

administration of 16 milligrams of morphine sulphate, may have contained a trace of morphine.

5 Quinine may be detected in 1,500,000 parts of milk but the amounts present in very low concentration slightly exceed those actually recovered.

6 Five doses, each of 300 milligrams of quinine sulphate were administered orally to two women and seven doses of 640 milligrams were given to four women. Traces of quinine could be detected in the milk in every case—in one instance in that drawn 30 minutes after the administration. None was found in milk drawn as late as 24 hours after the administration of the quinine.

7 The amount of quinine secreted in the mother's milk is too small to have any injurious effect upon the nursing infant.

#### REFERENCES

1. BUCURA, C. J. *Zachr. f. exper. Path. u. Therap.* 1907, 17, 398.
2. EVANS, W. T. *Brit. M. J.* 1885, II, 1159.
3. GAUSS, H. J. *Lab. & Clin. Med.*, 1920-1921, vi, 699.
4. HATCHER, R. A., and CROSSY, H. J. *Pharmacol. & Exper. Therap.* 1927, xxxii, 1.
5. JOACHIMOVITS, R. *Monatschr. f. Geburtsh. u. Gynec.*, 1920, lxxxiii, 42.
6. REED, C. B. *Surg., Gynec. & Obst.*, 1908, vi, 314.
7. TALBOT, F. B. *Am. J. Dis. Child.*, 1914, viii, 445.
8. THREMPER, M. *Monatschr. f. Geburtsh. u. Gynec.* 1899, x, 495, 644.
9. TRAVELL, J. *In press.*

# STRICTURES OF THE RECTUM DUE TO LYMPHOGRANULOMA INGUINALE<sup>1</sup>

DAVID BLOOM M.D. NEW YORK

From the Department of Dermatology and Syphilology of Bellevue Hospital and the University and Bellevue Hospital Medical College (services of Dr. Howard Fox)

**L**YMPHOGRANULOMA inguinale was described as a venereal disease in 1913 by Durand Nicolas and Favre. Its entity was proved by Frei (14) in 1925 when he discovered the intradermal test called since then the 'Frei test'. Of the extensive literature on this affection I wish to call attention to the thesis by Phylactos in 1922, the monograph by Fischl in 1927 and that of Hellerstrom in 1929. Of papers written in this country I wish to mention those of Pardo-Castello in 1926, of DeWolfe and Van Cleave and Sulzberger and Wise in 1937.

This so called "fourth venereal disease" deserves serious attention by the medical profession particularly surgeons, proctologists and also gynecologists, not because of the persistent inguinal adenitis with its discharging sinuses which occurs mostly in men but mainly because of the involvement of the deeper situated pelvic glands, the iliac hypogastric, and perirectal glands which leads to involvement of the rectal walls and finally to stricture.

In this paper I am trying to prove that a certain group of rectal strictures which for a long time has been baffling surgeons because of its obscure etiology is due to a previous infection with the lymphogranuloma inguinale virus.

## ESTHIOMÈNE, SYPHILOME ANORECTAL

The problem of this type of stricture is inseparable from the problem of 'esthiomène' which was described in detail for the first time by Huguier in 1848. It consists of obstinate chronic ulceration of the vulva associated with elephantiasis and sclerosis of the vulva, the anal region and the rectal wall, the latter involvement producing anal fistulas and rectal strictures. Fournier who considered the rectal involvement the main feature of the syndrome described it in 1875 under the name of 'sypilome anorectal' believing it due to

the early tertiary stage of syphilis. In his detailed description the following features are characteristic of this type of rectal stricture:

(1) In about 90 per cent of the cases involvement is seen when already degenerated into stricture. Due to the painlessness of the affection in the early stage the patient seeks medical advice at a late period of illness and the early stage has never been observed. The stricture is preceded by infiltration of the anorectal wall with a neoplasm the initial structure of which is unknown and which changes into fibrous tissue producing the stricture. (2) First there are changes in the rectal wall without any changes in the mucosa, later the mucosa is also involved and becomes infiltrated and ulcerated. (3) The most favored location is the ampulla of the rectum, more rarely the region of the sphincter. Fournier never saw involvement of the rectum above the ampulla in this type of stricture. It extends 4 to 6 centimeters vertically, sometimes as much as 8 centimeters and involves the whole circumference of the rectum. (4) Frequently both anus and rectum are affected with or without any interspace of healthy rectum. (5) The affection is rarely influenced by antisyphilitic treatment because of the advanced age of the process and the late administration of treatment. (6) This affection occurs much more frequently in women than in men, which fact was also mentioned by Huguier. (7) Pathologically it is a hyperplastic inflammation of the rectum. (8) The symptoms consist of difficult defecation, rectal purulent discharge with or without admixture of blood and of modification of the caliber of the stools. Frequently pus is discharged from multiple fistulas. (9) The affection lasts many years although the exact onset is unknown because of the fact that symptoms are produced only in the advanced stage.

<sup>1</sup>The cases of rectal strictures reported in this paper have been demonstrated by the author at the scientific exhibit of the New York State Medical Society at its annual meeting, on April 5, 1931, at New York.

Exactly the same type of stricture was described many years previously by the Danish surgeon Larsen who in 1849 reported 3 cases of hyperplastic infiltration of the rectum one of which had a vaginorectal fistula. Because these patients were prostitutes affected with syphilis Larsen considered this disease to be the cause of the stricture.

#### ETIOLOGY OF ESTHIOMÈNE AND SYPHILOME ANORECTAL

As this syndrome was found mostly in prostitutes, not only syphilis but also gonorrhea and *ulcus molle* were thought one time or another to be causative factors. Also tuberculous frequent trauma, and banal infection were considered by some the etiological factor. Because of the resemblance of the rectal affection and its frequent association with the ulceration and elephantiasis of the genitals and the anal region the same etiological factor was considered for both. Fabry in his monograph on *ulcus chronicum vulvae et ani* (*esthiomène*) gave a detailed chronological history regarding the discussion on the etiology of this affection. From the maze of opinions an important factor stands out mentioned by many investigators and still today considered of first importance in the causation of the affection cited above namely the previous total extirpation of the inguinal lymph nodes or their destruction due to inflammation and sclerosis. The first who introduced this factor into the discussion was Koch of Jadassohn's clinic. The other point worth mentioning is the question of syphilis as the cause of those conditions. In this connection there should be mentioned Bruhns Zieler and Jersild (22) who denied that there is any proof for syphilis to be the cause. The latter particularly pointed out that in a great number of patients it was impossible to detect syphilis, that the microscopic examination of the tissue did not show any syphilitic changes, and that antisyphilitic treatment was not efficacious. According to Jersild syphilis was not more frequent in the history of these patients with rectal stricture than in other venereal and pseudovenereal patients. Jersild elaborated and brought to a culmination the opinion which was frequently expressed in the

history of the etiology of the above described syndrome, namely that it is due to a disturbance in the lymphatic circulation. He pointed out that in 60 to 70 per cent of the cases there was a coexistence of elephantiasis vulvae and syphilome anorectal. It is to be assumed therefore that rectal involvement is also of elephantastic nature, which is confirmed by the clinical resemblance of the affected tissues in the genital, anal, and rectal regions, and also by pathological examination of excised tissue in all these regions. Jersild employed the term *elephantiasis genito-ano-rectale* which is frequently designated in the French literature as the Jersild syndrome.

Jersild called attention to the fixed localization of the hyperplastic infiltration and of the resulting stricture. For a complete explanation of the pathogenesis of the rectal stricture he utilized the findings of Gerota, of the Waldeyer laboratory in Berlin, who emphasized the following important points: (1) The ano-genito-inguinal lymphatic system communicates with that of the rectum by multiple anastomoses. (2) In the lateral wall of the rectum directly on the tunica muscularis, between the latter and the *fascia recti propria*, extending from immediately above the insertion of the levator ani muscle at the rectum up to the level at which the peritoneum reaches the lateral wall there are situated six to eight lymph glands which receive the lymph from the lower portion of the rectum. These glands were discovered by Gerota and are therefore called anorectal glands of Gerota.

These findings explain the diversion of the lymph flow toward the rectum in case of an obstruction of the lymph ways leading to the inguinal glands. They help also to understand why infectious agents, in case of obstruction in the ano-genito-inguinal lymph system will invade the anorectal glands of Gerota. These may then become inflamed and a "posterior" obstruction may be added to an "anterior" one. The region situated between these barriers will of course suffer from chronic lymphostasis.

Jersild brought out the interesting fact that the extension of the rectal involvement in the so called syphilome anorectal corresponds to

that part of the rectum along which are situated the glands of Gerota and the vessels collecting the lymph from the rectum below the insertion of the peritoneum. The lymph vessels which leave the rectal wall above the insertion of the peritoneum direct their flow not to the glands of Gerota but to the mesorectal lymph glands which are not affected and therefore there is no reason for the rectal wall in this location to become infiltrated.

In case the inguinal lymph glands or their lymph trunks are involved the external genitalia will suffer from the stasis. When the obstruction takes place in the lymphatics of the perineum the external genitalia may be exempt from the results of stasis. This would explain the presence of rectal without genital involvement. It would explain also the location of the stricture at the upper edge of the rectal infiltration for the anorectal glands of Gerota are most numerous immediately beneath the peritoneal pocket. It explains to Jersild also the fact of the predominance of those strictures in the female sex for the genital lesions in women are most frequently situated at the posterior commissure the posterior parts of the labia majora and at the introitus vaginae all regions the lymphatics of which anastomose abundantly with the anal lymph plexus. According to Jersild a combination of factors must co-operate in order to produce elephantiasis obliteration of lymphatics in a sufficiently extensive degree the presence of very few collaterals and an infectious agent of a special nature which in 1920 was still unknown to Jersild.

While the majority of investigators have gradually come to agree that the etiological factor in the production of those rectal strictures is to be found in the disturbance of the lymphatic flow there is confusion and uncertainty about the nature of this infectious agent. At one time Jersild believed that the agent of *ulcus molle* was responsible for the destruction of the inguinal and other glands leading to stasis elephantiasis, and stricture. The divergence of opinion as to the infectious agent coincides with the uncertainty and the divergence of opinion as to the etiology of the special type of inguinal adenitis which was called previously 'strumous bubo' or 'chi-

matic bubo' and which was finally found to be caused by the virus of lymphogranuloma inguinale.

This uncertainty and confusion about the etiology of those conditions described above as *esthiomène* *syphilome* *anorectal* etc., came to an end when Frei (15) suggested in 1927 the possibility of those conditions being due to the virus of lymphogranuloma inguinale. Frei and Koppel then proved this assumption by a positive Frei test in a number of cases of obstinate ulceration of the vulva associated with elephantiasis hypertrophy of the vulva anus and rectum. Since then numerous reports in the literature appeared confirming the above (Barthels and Biberstein (2) Kleeberg Fischer and Schmidt LaBaume Jersild (23) Lutz Loche and Rosenfeld DeWolfe and Van Cleve, and others). Jersild agrees with Frei and others that the large majority of cases of elephantiasis anorectale is due to lymphogranuloma inguinale. Like Frei he is of the opinion that not every such case is the result of previous infection with lymphogranuloma inguinale although the frequent association of those conditions with lymphogranuloma inguinale seems to speak for absolute dependence.

The connection of the genito-anorectal syndrome with lymphogranuloma inguinale was proved also in many other ways. Meyer and Rosenfeld excised a granulomatous growth of the labia minora in a case of *esthiomène* inoculated it into a guinea pig and proved the pathological resemblance of the resulting mass with lymphogranuloma in guinea tissue.

Reiss showed a typical lymphogranuloma inguinale infection in the partner of an *esthiomène* case. Nicolas, Favre Lebeuf and Charpy obtained a positive Frei reaction in lymphogranuloma inguinale patients with an antigen prepared from the pus of a fistula from a patient affected with the anorectal syndrome. Ravaut, Levaditi Lambling and Cachera inoculated guinea pigs with the ulcerated growth from the anus and rectum and transferred from them the infection successfully to monkeys producing lesions like those obtained with lymphogranuloma inguinale virus.



TABLE 1.—LOCATION

Location above the anus	Cases
1	29
2 to 3	98
3 to 4	42
4 to 5	26
5 to 6	8
6 to 7	3
The whole rectum involved	42
Rectum and sigmoid	5

Loeche and Rosenfeld inoculated a monkey intracerebrally with a piece of a tumor like growth of a labium minus from a patient with esthiomène and the extract of the monkey brain gave a positive Frei reaction in two lymphogranuloma inguinale patients.

#### BENIGN RECTAL STRICTURES

It is of interest and significance that the type of rectal stricture mentioned above resembles in many respects the conditions described in the literature under the name of "benign" or "inflammatory" strictures of the rectum. The uncertainty about the etiology of these strictures equaled until lately the uncertainty about the etiology of the strictures associated with the above described syndrome of esthiomène and syphilomè anorectal. This uncertainty is expressed even in the most recent textbooks on diseases of the rectum.

Also for this type of stricture all kinds of infection, particularly venereal infections were thought to be the cause. Huber found rectal gonorrhoea in 25 per cent of prostitutes affected with gonorrhoea. Poelchen only in 10 per cent. Baer of Herzberger's clinic, however found in 163 cases of rectal gonorrhoea only one stricture. Hayes also maintains that the probable source of rectal stricture is gonorrhoea. In 78 cases of rectal stricture he found that 54 patients were affected with gonorrhoea.

Also tuberculosis was considered as the cause of rectal stricture. Ruge, however found among 18 histologically examined strictures only once typical tuberculous changes. Schreiner Bienert found among 14 cases 2 in which tuberculous etiology could be considered. Barthels and Biberstein (2) found 1 case among 14 strictures in which tuberculosis could be considered but the

histological examination did not prove this assumption.

The majority of authors considered syphilis as the cause of the "benign stricture." Mummery however expressed the opinion in 1914 that syphilitic stricture is exceedingly rare. The presence of syphilis in a patient with rectal stricture does not necessarily mean that the lesion is due to syphilis. According to Mummery the statement that tertiary syphilis was the most common cause has been copied from textbook to textbook. Forty years ago it was customary to ascribe to syphilis most of the chronic lesions of the body of uncertain origin. He was unable to prove that syphilis caused any of the rectal strictures which he saw at St. Mark's Hospital in London. Out of many thousands of cases of rectal stricture at this hospital only two or three were recorded as syphilitic.

Kallet found among 75 cases of rectal stricture 39 with a positive blood Wassermann test, and he remarks that "this figure is not higher than that secured from similar social and ethnic groups not affected with proctitis." According to Barthels and Biberstein stricture is a rare complication in syphilis. They quote Schede who found among 18 000 syphilitic women only one rectal stricture.

Schreiner Bienert found inflammatory strictures in women leading a loose life but he nevertheless denies syphilis as a cause. In those patients who had syphilis he never found any syphilitic changes in the rectal tissue.

In 1923 Bule reported an analysis of 258 cases of benign rectal stricture which were observed at the Mayo Clinic from 1912 to 1922 and found that 53 cases had some evidence of having or having had syphilis. Bule, therefore, denies syphilis to be the cause. According to him the strictures are probably due to extensive and often repeated operations which were performed in attempts to eradicate tuberculous tracts.

The following features were noted by Bule, which are of interest when compared with the already mentioned description of the strictures by Fournier, Jersild and others in the syndrome of "syphilomè anorectal."

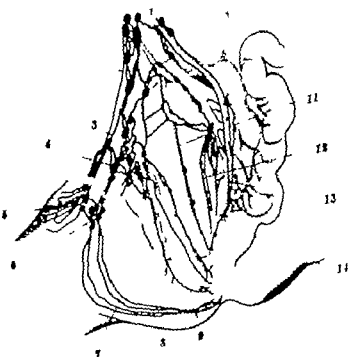


Fig. 1. The lymphatics of the anus and rectum and their relation to the lymphatic system of the pelvis and inguinal region (V Semba). 1. Aorta abdominalis. 2. Arteria iliaca communis dextra. 3. Arteria iliaca externa dextra. 4. Glandulae iliacae inferiores. 5 and 6. Glandulae inguinales. 7. Vasa lymphatica inguinalia medialis. 8. Vasa lymphatica haemorrhoidalis inferiora. 9. Vasa lymphatica haemorrhoidalis media. 11. Vasa lymphatica sacralia media. 12. Vasa lymphatica sacralia lateralia. 13. Vasa lymphatica sacralia superiora. 14. Ampulla recti.

#### LOCATION

From Table I it is seen that the greatest majority of strictures were located within the lowest 10 centimeters above the anus. The fact that 53 cases suffered also of ulcerative colitis may probably partly account for the 42 cases which showed involvement of the entire rectum and the 5 cases of involvement of the rectum and sigmoid. These probably do not belong etiologically to the strictures considered in this paper. These findings in regard to location of the stricture correspond to those of Perret who noted in 60 cases of benign stricture the following localization: anus 4 cases, below 6 centimeters 32 cases, 6 to 9 centimeters 14 cases, and at the junction of the colon 6 cases.

The duration of the stricture in Buie's cases was as follows: Less than 1 year 43 cases, 1 to 2 years 22, 2 to 5 years 54, 5 to 10 years 76, 10 years and more 41. 22 cases were of unknown duration.

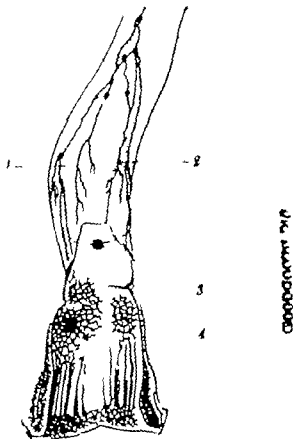


Fig. 2. Shows the close connection between the lymphatics of the mucosa of the ampulla and the anal portion of the rectum (V Semba). 1. Vasa lymphatica haemorrhoidalis superiora. 2. Arteria haemorrhoidalis superior. 3. Ampulla recti. 4. Lymph network and nodules.

In Buie's cases there were 120 women and 138 men. This finding differs from the analysis of most other investigators who found a large preponderance in the number of strictures in women. Biberstein explains this finding by the fact that 57 per cent of the cases in Buie's series were postoperative strictures which would possibly account for the preponderance in men. Hayes' series showed 83.18 per cent women. Tuttle found among 313 cases 216 women. Poelchen among 215 cases 190 women. Carré reported 210 women and 51 men. Ruge 61 women and 2 men. Rankin however reported 160 men and 128 women.

#### SYMPTOMS

The patients usually give a history of anal fistulas, mucopurulent and bloody discharge from the rectum, painful defecation and finally obstinate constipation. In the beginning there is only discharge from the rectum, later pain and symptoms of stenosis appear.



Fig. 6. Discharging sinus 18 months after development of inguinal adenitis.

and also between the superficial and the deep lymphatics.

These conditions of the lymphatic circulation make it easy to understand the rectal involvement which is the most serious part of the lymphogranuloma inguinale infection. The importance of this venereal disease is not to be looked for in the inguinal adenitis as it was previously assumed, but in the involvement of the deep pelvic glands, the iliac, hypogastric and anorectal glands of Gerota. Hence the justification on the part of Barthelemy and Biberstein to change the name of lymphogranuloma inguinale to "lymphadenitis granulomatodes venerea" or to "lymphopathia venerea" as Wolf and Sulzberger suggested. The inguinal adenitis should be considered only as an external manifestation of the illness.

The infection of the deep glands may take place simultaneously with the development of the inguinal adenitis or alone without any external manifestation. Even in men together with the inguinal adenitis, the iliac gland involvement may be felt in the beginning of the illness as a firm mass deep in the iliac fossa. This fact was first pointed out by Frel and may be considered as a diagnostic sign. In women in the majority of cases the lymphogranuloma inguinale infection is not manifested by inguinal adenitis, for the lymph vessels lead from the primary lesion on the genitals mostly directly to the deep pelvic glands omitting the inguinal lymph glands. The glands invaded by the virus are destroyed and this leads to chronic lymphostasis in the regions draining into these glands. These



Fig. 7. Defect in filling and partial stenosis of the anal canal and the adjacent portion of the rectum.

regions are the genitals, the anal region and the rectum. Upon the extent of destruction of these glands depends the extent of the lymphostasis. The genital, anal, and rectal regions may be affected together or separately.

That the sequelae of lymphogranuloma inguinale namely elephantiasis of the genitals and anus, and rectal stricture do not occur in men as frequently as in women is also understood, for the lymph vessels of the genitals in men lead mostly and primarily to the inguinal glands. If the involvement of the deep pelvic glands takes place it is in most cases only secondarily and not in such a degree as in women. Besides, one must think of the fact mentioned by Roegholt, that in men there are abundant anastomoses between the lymphatics of the right and the left sides and the deep and superficial vessels, so that the result of lymphostasis might not be developed in such a marked degree as in women where there are few anastomoses.

The chronic lymphostasis leads to disturbance in nutrition of the affected region. The disturbance might manifest itself in a regressive form leading to chronic ulceration associated usually with the productive form,



Fig. 8. Lower portion of the rectum is obscured. The rectum terminates into stenotic area.



Fig. 9. Defect in filling of the lower fourth of the rectum.

the proliferation of connective tissue resulting in elephantiasis and finally in shrinkage producing the stricture of the rectum.

Is this affection of the rectum the result of lymphostasis only or has the specific lymphogranuloma inguinale virus some part in the causation? The opinions of investigators are divided on this question. Loehe and Rosenfeld believe that it is quite possible that there is not only obstruction of lymph ways but also retrograde transportation of infectious material from the pelvic glands into the skin of the affected regions and into the rectal wall so that the resulting changes are at least partly specific ones due to the virus of lymphogranuloma inguinale. These authors have seen bubonuli appear in the dorsal lymph trunk of the penis several weeks after superficial and deep inguinal infection pus obtained from these bubonuli gave a positive reaction in lymphogranuloma inguinale patients. This case could only be explained by the retrograde lymph transport of infectious material. In a second case of bilateral inguinal involvement

the authors have seen in the triangle of Scarpa of the thigh several subcutaneous infiltrations ulcerate. The excised ulcerated tissue proved histologically and by animal inoculation to contain the virus of lymphogranuloma inguinale.

Barthels and Biberstein (3) also believe that the changes in the genitals and the rectal wall are not produced through stasis alone. The local inflammatory process is supported through specific processes. The lymphogranuloma inguinale virus is able to produce a proliferation stimulus in the surrounding tissues as in filariasis. These authors have found the same structure in the elephantiasis tissue as in glands infected recently with lymphogranuloma inguinale virus.

The same opinion is shared by Nicolas Favre, Massia and Lebeuf (33). Jersild and Frei however are inclined to the conception that those changes are the result of lymphostasis alone perhaps supported by secondary



Fig. 10. Persistent defective filling of the rectum. Not consistent with malignancy.

infection. Jersild has never seen in the elephantiasis any other change than simple chronic inflammation.

#### REPORT OF CASES

Inspired to verify and if confirmed to help to spread the knowledge on the etiology of a certain group of rectal strictures I have approached the rectal departments of Bellevue Hospital and found perfect and interested co-operation by Dr. Lester Breidenbach of the 4th Surgical Division (Director Dr. Carl G. Burdick) and by Dr. Frank Brown Berry of the First Surgical Division (Director Dr. J. A. McCreery).

In studying the cases, I have looked up their previous records in the hospital and incorporated them in the reports. In order to visualize the defect in the rectum roentgenograms were taken of the rectum following a barium enema and compared with the roentgenogram of a normal rectum (Fig. 5). Dr. Lewis J. Friedman, director of the Roentgenology Department, has kindly co-operated



Fig. 11. Decided stricture of entire rectum. Borders of constricted lower half of rectum are irregular.

Because of lack of space I shall give a detailed report on only one case and consider the 6 others in the analysis.

B. M., aged 48 years, white woman, born in U. S., had been a patient in Bellevue Hospital several times. In March, 1931, she was operated on for a submucous fibroid by an hysterectomy. At that time both adnexa were found collapsed in the cul-de-sac, thickened, and bound down by numerous adhesions. The left adnexa which were four times the normal size were removed.

In October, 1932, the patient was readmitted to the hospital because of discharging sinuses in both inguinal regions, resulting from inguinal buboes which broke down after 3 months' duration. In the rectum a hard mass was found which was attached to the posterior wall of the vagina. The diagnosis made at that time was "fibroma of the rectum, possibly malignant."

A year later the patient was readmitted to the hospital complaining of pus and blood in the stools and painful defecation which started 9 months previously. According to the patient difficulty in moving the bowels started in March, 1931, soon after the hysterectomy and salpingo-ovarectomy.

The diagnosis on admission was "Stricture of the rectum, probably syphilitic. Possibility of carcinoma." Digital examination of the rectum re-



Fig. 12. Definite stenosis of the entire rectum. Lumen diminished to one-fifth of its normal size.

vealed on the posterior wall a crater like cavity with firm raised edges. About 1 inch from the anus there was a reduction in the size of the lumen and the finger felt as though it were encircled by a band. A small firm mass was also felt on the anterior wall. No blood or pus was found on the examining finger. In the anal canal and the rectum there were firm nodules, not tender apparently covered with mucosa. On the posterior wall of the anal canal there was a 2 centimeter long fissure. At a distance the fully extended examining finger felt a rather large firm mass chiefly in the right wall seemingly extending around the lumen of the rectum. The proctoscopic examination of the rectum showed a complete posterior fistula in-ano and inflammatory ulceration on the posterior and lateral wall of the rectum. This does not suggest malignancy. Diagnosis: Complete fistula with ulceration proctitis inflammatory induration. The involvement of the inguinal gland may be secondary to perianal infection.

One small nodule from the posterior wall was excised and examined microscopically. The report from the pathologist was "Chronic productive inflammatory tissue."

When seen in the skin clinic in October 1932 the patient complained of general weakness of pain in the right shoulder and inability to raise the right arm. In the left inguinal region there was a hori-



Fig. 13. Diffuse stricture involving entire rectum.

zontal linear depressed scar and in the right inguinal region there were several sinuses discharging muco-pus (Fig. 6). In the right iliac fossa there was an orange sized, irregular firm palpable mass which was doubtless due to involvement of the iliac glands. She did not give any convincing history of syphilis.

The Wassermann test of the blood was negative and the cerebrospinal fluid removed by cisternal puncture was normal. Frei tests done with several lymphogranuloma inguinale antigens, also with the extract of the brain of a monkey which had been infected with lymphogranuloma inguinale virus gave strongly positive reactions every one of the reaction papules broke down in the center and peristed for weeks. Roentgenogram of the rectum following a barium enema was reported as defect in filling and partial stenosis of the anal canal and the adjacent portion of the rectum (Fig. 7). The blood count was normal except for mild leucocytosis. The erythrocyte sedimentation test which was done according to the method of Luzzanmeier was 32 minutes.

The treatment consisted of intravenous injections of 1 per cent solution of tartar emetic, starting with 2 cubic centimeters and increasing up to 7 cubic centimeters. It was given twice weekly. This was combined with subcutaneous and intramuscular injections of lymphogranuloma inguinale antigen. Considerable improvement took place in her general condition. The pain in the arm and the rectal discharge diminished and general weakness and pain in the rectum disappeared. The sinus in the right groin closed.

## ANALYSIS OF SEVEN CASES OF RECTAL STRICTURE UNDER OWN OBSERVATION

Seven cases of rectal stricture were under my observation in the years 1937-1933. Their histories were briefly

There were 3 men and 4 women. Four of the patients were colored and 3 white. All of them gave a positive Frei reaction to several lymphogranuloma inguinale antigens. In all the 3 men there was a history of previous involvement of the inguinal glands, the signs of which were still visible as scars. Of the women only 1 gave a history of involvement of the inguinal glands, the remnants of which were seen in form of a scar and persistent discharging sinuses. The time elapsed between the involvement of the inguinal glands and the appearance of rectal signs and symptoms ranged from 1 month to 15 years, the average being 4.8 years. Fistulas were present in 4 patients and a fissure in 1. The location of the stricture was such in all 7 cases that the examining finger could easily reach the stricture. Three showed involvement of the lower part of the rectum (Figs. 8, 9) and in 4 the entire rectum was involved (Figs. 10, 11, 12, 13). The duration following the appearance of the symptoms or signs at the time when the Frei test was done varied from 1 to 14 years, an average of 3.5 years.

The Wassermann test of the blood was negative in all the patients at the time when the Frei test was done, but the history of syphilis was definite in 2, indefinite in 4 cases, and negative in 1. Pathological examination of rectal tissue made in 5 patients revealed only simple or chronic productive inflammation.

The treatment for lymphogranuloma inguinale, namely tartar emetic, or gold injections greatly benefited the general health and the local rectal affection. This we ascertained in 5 patients, while in 2 the result of treatment could not yet be seen.

The fact that the Frei test was positive in all the 7 cases studied and that they were definitely benefited by the treatment for lymphogranuloma inguinale, make it fairly certain that those strictures are produced by the lymphogranuloma inguinale virus. The justified thought that the earlier the rectal involvement is discovered and treated the greater the prospect of preventing the stricture calls for an early diagnosis of lymphogranuloma inguinale.

The diagnosis of lymphogranuloma inguinale especially in men is suggested by the presence of inguinal adenitis. But also in women much could be accomplished if any involvement of the rectum would make one consider the possibility of a preceding lympho-

granuloma inguinale infection. Also in gynecological conditions, like involvement of the adnexa a Frei test should be done in order to exclude lymphogranuloma inguinale. Barthels and Biberstein have noted in the history of those patients with rectal stricture extensive pelvic inflammation, tumors of the adnexa, abscess formation in these tumors and in the anorectal wall, and periproctitic perforating abscesses.

Before any major operation is to be undertaken in cases of rectal stricture treatment for lymphogranuloma inguinale should be given a test, which, judging from the cases reported in this paper might make such operations unnecessary particularly if treatment is administered early and not after scar tissue has formed.

Sufficient Frei antigen should be on hand in order to provide surgical and gynecological wards. This could be accomplished by injecting a monkey intracerebrally with 1 cubic centimeter of the pus from a lymphogranuloma inguinale gland. The brain and the cord from such a monkey who dies or is killed after several weeks would furnish an abundant amount of antigen. Our Department of Dermatology has in mind to carry this out at the first opportunity.

The purpose of this paper is to convince or at least stimulate the interest of the medical profession particularly the surgeons, in this disease so that further study could be carried out. For lymphogranuloma inguinale is not a purely dermatovenereal problem, it transgresses far into the realm of internal medicine and surgery.

## SUMMARY AND CONCLUSIONS

1. A review of the literature of *ethiome* and "syphilome ano-rectal" on the one hand and of the so called "benign strictures of the rectum" on the other hand showed a remarkable resemblance in the confusion regarding their etiology. Most if not all, of these conditions are identical and are due to the virus of lymphogranuloma inguinale.

2. A description has been given of the lymphatic circulation in the genital, anal, and rectal regions in both men and women.

3 Seven cases of rectal stricture have been reported, all of which reacted positively to the Frei test and 4 of which gave a history of broken down inguinal glands. They have benefited from the treatment which is usually administered for lymphogranuloma inguinale.

4. A plea is made for an early diagnosis of lymphogranuloma inguinale. By doing a Frei test in every case of rectal involvement stricture of the rectum might be prevented.

## BIBLIOGRAPHY

1. BAKER. Quoted by Ruge.
2. BARTHÉLIS, C., and BERNSTEIN H. Zur Ätiologie der entzündlichen Rektumstricturen, Lymphogranuloma inguinale als Grundkrankheit. Beitr. z. klin. Chir., 1931, ciii, 161.
3. BARTHÉLIS, C., and BERNSTEIN H. Elephantiasis penis et scroti und Lymphogranulomatosa inguinale. Beitr. z. klin. Chir., 1931, ciii, 325.
4. BERNHAUD and LAMOLINO. Le rôle de la maladie de Nicolas-Favre dans l'étiologie du rétrécissement inflammatoire du rectum. Étude de 21 cas par l'intradermo-réaction de Frei. Compt. rend. Soc. de biol., 1931, cviii, 1090.
5. BRUNDT, C. Venereische Krankheiten in Flecke. E. Lehrbuch der Haut und Geschlechtskrankheiten, 5th ed. p. 647. Jena. Gustav Fischer 1920.
6. BUTT, LOUIS A. Benign strictures of the rectum. J. Am. M. Ass., 1933, lxxxi, 1357.
7. CARRÉ. Quoted by Hartman, H. Lancet, 1922, i, 307.
8. DEWOLFE, H. F., and VAN CLEVE, J. V. Lymphogranuloma inguinale. J. Am. M. Ass., 1933, xcix, 1065.
9. DURAND, J., NICOLAS and FAVRE. Lymphogranuloma inguinale subaigue d'origine génitale probable peut-être vénérienne. Bull. et mém. Soc. méd. d. bôp. de Par. 1913, xxxv, 274.
10. FADRY J. Ulcus cronicum vulvae et ani, in Jadasohn, J. Handbuch der Haut und Geschlechtskrankheiten. Vol. xxi, p. 415. Berlin Julius Springer, 1927.
11. FISCHER A. W., and SCHMIDT LABAUDE. Rektal stricturen und Lymphogranuloma inguinale. Deutsche med. Wchnschr. 1933, lviii, 527.
12. FISCHER, F. Lymphogranulomatosis inguinale, in Jadasohn, J. Handbuch der Haut und Geschlechtskrankheiten. Vol. xxi, p. 463. Berlin Julius Springer 1927.
13. FOURNIER, A. Leçons sur la syphilis tertiaire. Bureau du journal l'école de médecine. P. 157. Paris, 1875.
14. FREI WILHELM. Eine neue Hautreaktion bei Lymphogranuloma inguinale. Klin. Wchnschr., 1925, iv, 2148.
15. FREI, W., and HOFFMANN H. Experimentelles und Klinisches zum "Lymphogranuloma inguinale." Arch. f. Dermat. u. Syph. 1927, cxiii, 170.
16. FREI W., and KOPPEL, A. Ulcus vulvae cronicum elephantiasicum (esthiomène) und sogenanntes Syphilome ano-rectal als Folgeerscheinungen der Lymphogranulomatosis inguinale. Klin. Wchnschr. 1932, vii, 2331.
17. GEROTA D. Die Lymphgefäße des Rektums und des Anus. Arch. f. Anat. u. Physiol., 1895, p. 240.
18. HAYES H. T. Stricture of rectum with special reference to stricture in the colored race. report of 160 cases. Tr. Am. Proctol. Soc., 1931, xxxii, 173.
19. HELLERSTROM, SVEN. A contribution to the knowledge of lymphogranuloma inguinale. Acta dermatol. venerol. (Suppl. I) 1929.
20. HUBER A. Ueber periproctitis gonorrhoea. Arch. f. Dermat. u. Syph. 1897, xi, 237.
21. HUGUET, P. C. Mémoire sur l'esthiomène ou dartre rougeante de la région vulvo-anale. Mém. Acad. nat. d. méd. 1849, xiv, 501.
22. JERSILD O. Notice historique sur l'infiltration hyperplasique du rectum avec rétrécissement fibreux et sur l'origine prétendue syphilitique de cette affection. Ann. de dermat. et syph., 1926, vii, 74. Elephantiasis genito-anorectalis. Dermat. Wchnschr. 1933, xcvi, 433.
23. Idem. Quatre nouveaux cas de syphilome ano-rectal et d'esthiomène avec intradermo-réaction de Frei positive. Bull. Soc. franç. de dermat. et syph. 1931, xxxviii, 537.
24. KALLET H. J. Proctitis obliterans. J. Michigan M. Soc. 1926, xxv, 468.
25. KLEBERG. Bull. Soc. franç. de dermat. et syph. 1931, xxxviii, 540.
26. KOCH, F. Ueber das "Ulcus vulvae" (chronicum elephantiasicum, etc.) Arch. f. Dermat. u. Syph. 1896, xxiv, 205.
27. LARSEN S. E. Praktiske Bemærkninger over Stricture i Mastarmen. Hospitals-Meddelelser 1849, ii, 280.
28. LOEWI, H. and ROSENFIELD H. Neue Ergebnisse ueber die Spätformen des Lymphogranuloma inguinale (Esthiomène) Med. Klin. 1933, xxviii, 1486.
29. LUTZ, K. Entzündliche Rektumstricturen durch Lymphogranuloma inguinale. Deutsche med. Wchnschr. 1933, lviii, 1360.
30. METZER K., and ROSENFIELD, H. Erfolgreiche Uebertragung des Lymphogranuloma inguinale auf Meerschweinchen. Klin. Wchnschr. 1931, x, 1653.
31. MUMFERY P. LOCKHART. Diseases of the Rectum and Colon and their Surgical Treatment. Pp. 381-636. London. Baillière, Tindall and Cox 1923.
32. NICOLAS, J. FAVRE M. LÉNEUF F., and CHARPY J. Intradermo-réactions positives dans la maladie de Nicolas-Favre (trois cas) avec un antigène tiré d'une forme ano-rectale élephantiasique de la maladie. Bull. Soc. franç. de dermat. et syph. 1932, xxxix, 24.
33. NICOLAS, FAVRE MAMMA, and LÉNEUF Rétrécissement ano-rectal élephantiasique de la maladie de Nicolas-Favre. Bull. Soc. franç. de dermat. et syph., 1931, xxxviii, 533.
34. PARDO-CASTELLO V. Lymphogranulomatosis inguinale. Arch. Dermat. & Syph. 1926, xiv, 35.
35. PERRET. Quoted by Ruge.
36. PHYLIACLOS, ADRIEN. Lymphogranulomatose des ganglions inguinaux. Thèse de Lyon 1922.
37. POELCHEN R. Ueber die Ätiologie der strikturierenden Mastdarmschwere. Arch. f. path. Anat. 1892, cxviii, 180.
38. RAVAUT P., LEVATIN C., LAMBLING A. and CHIERA R. La présence du virus de la maladie de Nicolas-Favre dans les lésions d'un malade atteint d'anorectite ulcéro-végétante. Bull. Acad. de méd. 1932, xcvi, 98.
39. RANKIN FRED W., BARGEN ARNOLD J. and BUTT LOUIS A. The Colon, Rectum and Anus. Philadelphia. W B Saunders Company 1932.



40. RAZZE, Dermat. Ztschr. 1932 hrl 338.
41. ROXOROLI M N Das genito-rectale Syndrom. Klin. Wchnschr., 1930, xlv, 1064.
42. RUGE, E. Zur Pathologie und Therapie der Proctitis parulenta und ulcerosa. Arch. f. klin. Chir. 1907 lxxviii, 341.
43. SCHWENKER BUDDECK Ueber entzündliche Strikturen des Rektums. Deutsche Ztschr. f. Chir. 1930, cccxviii, 105.
44. SIMON, Y. Anatomische Untersuchungen ueber das Lymphgefäßsystem des Rektums, mit besonderer Berücksichtigung der Metastasenbildung des Rektum Karzinoms. Arch. f. klin. Chir. 1938 cxlix 336.
45. STRAUSS, H. die Aetiologie der venerischen Rektalstrikturen. Dermat. Wchnschr. 1913, xlv, 235.
46. SULZBERGER, M. B., and WHEE, FRED. Lymphopathia Venerea. (Lymphogranulomatosis Inguinalis of Nicolas, Favre and Durand) J. Am. M. Ass., 1932, xcix 1407.
47. TUTTLE, J. P. A Treatise on Diseases of the Anus, Rectum and Pelvic Colon. 3d ed. p. 463. New York D. Appleton and Company 1905.
48. WOLF J., and SULZBERGER, M. B. Lymphopathia Venerea. Brit. J. Dermat. 1932, xlii 102.
49. ZIEGLER, KARL. Lehrbuch und Atlas der Haut und Geschlechtskrankheiten. P. 117 Berlin und Vienna. Urban and Schwarzenberg, 1934.

THE CURABILITY OF CARCINOMA OF THE LARYNX<sup>1</sup>

GORDON B. NEW, M.D., F.A.C.S., ROCHESTER, MINNESOTA  
 Section on Laryngology, Oral and Plastic Surgery, The Mayo Clinic

JOHN M. WAUGH, M.D., ROCHESTER, MINNESOTA  
 Fellow in Surgery, The Mayo Foundation

IT is apparent that physicians in general are not acquainted with the good results obtained in the surgical treatment of carcinoma of the larynx, that is, the very small operative mortality and the high percentage of 5 year cures. The good voice that results from thyrotomy in cases in which the lesions are localized, and the ease with which the patients are rehabilitated following laryngectomy in the more advanced cases are noteworthy. We have studied the curability of this disease in 107 traced cases in which operation had been performed at The Mayo Clinic previous to 1928.

## EARLY DIAGNOSIS

In the last decade the diagnosis of carcinoma of the larynx has been made earlier due largely to the recognition by physicians that hoarseness which has lasted more than a month may be due to carcinoma.

Carcinoma of the larynx is more common among men than among women. Only 8 per cent of our series of patients were women. The average age of the patients was 55 years, but the disease occurs among young persons. We performed laryngectomy on 3 patients aged less than 23 years.

In cases of suspected carcinoma of the larynx the surgeon who is to do the operative work should examine the patient before biopsy is made. Although biopsy is essential in many cases in order to establish a diagnosis it is sometimes carried out with considerable trauma, and on examination a few days later it is difficult to determine whether the growth or the reaction from the biopsy has produced much of the enlargement. Biopsy, if necessary, should be done by the surgeon before the operation, and the patient and the relatives should be informed as to the treatment which will follow should the lesion prove to be a malignant one.

## SELECTION OF TREATMENT

Certain types of relatively conservative operations are justifiable for carcinoma of the larynx, as is shown by the end results in selected cases. The type of operation should depend on the degree of the malignancy of the lesion, the extent of the growth, its situation, and the other factors usually considered.

Carcinoma of the epiglottis, which is usually of low grade malignancy, may be removed with surgical diathermy by means of a suspension apparatus. The operation is preceded by tracheotomy. This does not require pharyngotomy as is done in the more advanced cases, and the results have been exceptionally good.

Thyrotomy with or without removal of the cartilage is indicated for early carcinomata involving the anterior two-thirds of the vocal cord, the growth being excised and the base destroyed with diathermy. If the growth affects both vocal cords anteriorly then this entire area may be removed following the method of Jackson. Thyrotomy and removal of the cartilage, as practiced by Thomson, is a valuable method of treatment for unilateral growths in the anterior part of the larynx with fixation. Surgical diathermy is also valuable. However, a large percentage of these growths perforate through the entire thickness of the larynx; therefore cases for conservative operation should be carefully selected.

Laryngectomy should be performed if the lesion is highly malignant unless local excision can be made far enough from the growth to eliminate the possibility of local extension by the lymphatic vessels beyond the area removed. If the epitheliomata are of low grade malignancy, an excision 0.75 centimeters clear of the growth will be sufficient; if they are of high grade malignancy, a much wider margin of apparently normal mucous membrane must be removed with the tumor.

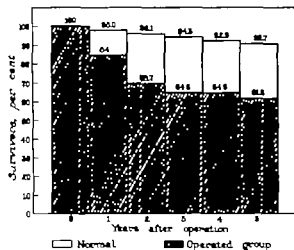


Fig. Life expectancy in epithelioma of the larynx.

Pharyngotomy is performed for more advanced growths in the region of the epiglottis and base of the tongue the aryepiglottic fold, and the postcricoid region.

Removal of the cervical lymph nodes if they are involved depends on the activity of the lesion in addition to the other factors usually considered. If the lesions are of low grade malignancy block dissection of the neck should be done. One patient with cervical metastasis, graded 2 lived 14 years following laryngectomy and block dissection. If lesions are of high grade malignancy with lymphatic involvement, much can be accomplished by irradiation. Inserting radon and radium points at the time of operation into the area where recurrence is possible has a definite place in the treatment of these lesions.

#### RESULTS

A review of the literature reveals that excellent results have been obtained in the surgical treatment of carcinoma of the larynx. Colledge and Peacock reported 53 cases of carcinoma of the larynx in which laryngectomy was performed in 42 and thyrotomy in 11. There is no report of 5 year cures in this series but 1 patient lived 10½ years following laryngectomy and 1 patient lived 8½ years following thyrotomy. The authors stated that 80 per cent of the patients on whom thyrotomy had been performed are free from recurrence.

Lewis reported 10 cases in which thyrotomy had been performed with 5 year cures in 4. One patient died of recurrence. The 5 other patients did not have recurrence but were operated on less than 5 years ago. He reported 83 cases in which laryngectomy was performed 53 patients (63 per cent) are living without recurrence and 32 of them have been well for 5 years.

Mackenty reported 102 cases in which laryngectomy had been performed with 4 deaths. Five year cures were not mentioned. From 1917 to 1922 he performed laryngectomy in 31 cases with 5 recurrences, and from 1922 to 1926 in 58 cases with 5 recurrences.

Thomson reported 70 cases in which thyrotomy was performed and after deducting the operative deaths and deaths from other causes, there were lasting cures in 76 per cent. He performed thyrotomy in 50 consecutive cases without an operative death.

Crile reported 27 cases in which laryngectomy was performed with 2 operative deaths, and Mullin reported 27 traced cases in which laryngectomy had been performed during a period of 10 years with 16 (55 per cent) deaths from the disease. Of 12 traced cases in which thyrotomy had been performed good results were obtained in 66 per cent. Five year cures were not reported.

Tapia reported performing laryngectomy in 107 cases with 5 deaths. Orton reported 32 cases with 3 deaths, and Lynch reported 152 cases with 2 deaths. 62 per cent of Lynch's patients are well without recurrence.

In The Mayo Clinic thyrotomy has been performed in 75 consecutive cases of carcinoma of the larynx with no operative deaths. We feel that the results are due largely to the fact that a 2 stage operation was performed on elderly patients, and on those who were poor surgical risks. In a series of 60 consecutive cases in which laryngectomy was performed, there was only 1 operative death. This makes a total of 135 operations for carcinoma of the larynx with 1 operative death.

Excluding the patients who died from other causes, those who were not traced and the operative deaths, there were 107 traced patients operated on at The Mayo Clinic previous to 1928. On the results obtained by

TABLE I—CARCINOMA OF THE LARYNX  
(107 PATIENTS)

Oper. time	Patients traced	Five year cures		Cures in years					Still living
		Patients	Per cent	7	10	15	20		
Thyrotomy	34	28	82.3	15	8	3			3
Laryngectomy	73	41	56.1	24	18	8	8		22
Total	107	69	64.5	39	27	11	8		25

Average time elapsed since operation is 9 years and 4 months the shortest time, 2 years, and the longest time, 24 years.

these patients the curability of carcinoma of the larynx is based. Thyrotomy was performed on 34 of these patients and 28 (82.3 per cent) obtained 5 year cures. Laryngectomy was performed on 73 and 41 (56.1 per cent) obtained 5 year cures. Of the total group of 107 traced patients 69 (64.5 per cent) obtained 5 year cures. In Table I it may be noted that 53 patients obtained 7 year cures, 27 obtained 10 year cures, 8, 15 year cures and 3, 20 year cures. Fifty-six patients are still living. The average time elapsed since operation on the 56 living patients is 9 years and 4 months, the shortest time, 5 years and the longest time, 24 years (Fig. 1).

We feel that the grade of malignancy is a factor in determining the advisable treatment in the individual case and also in determining the prognosis. In 78 cases graded microscopically the grade has a definite relation to the percentage of 5 year cures (Table II).

#### THE VOICE

Following thyrotomy for unilateral growths of the larynx, the voice is usually good. A scarred band forms and replaces the area from which the growth was removed and the opposite cord approximates this to produce a useful voice. The amount of tissue removed and whether one or both cords are involved, determines the end results. If the lesions are small, surprisingly little postoperative deformity will be noted after the tissues have healed completely.

Following laryngectomy speech must be produced either by the muscles of the pharynx or by an artificial voice box. A small percentage of patients are able to talk with little effort by using the pharyngeal muscles, the

TABLE II—CARCINOMA OF THE LARYNX 78  
CASES GRADED MICROSCOPICALLY

	Patients traced	Five year cures	
		Patients	Per cent
Grade 1	2	2	100
Grade 2	44	25	56.8
Grade 3	7	18	66.6
Grade 4	6	0	0
Total	78	44	56

voice sounds like that of a patient with a mild laryngitis. This is the ideal result in such cases but it can be accomplished only in a small percentage of them. The intelligence of the patient is a large factor in producing such a result. The second type of pharyngeal speech produced by the patient swallowing air and then belching it up in spasms is not so satisfactory, and we feel that an artificial voice box is preferable to this type of speech. All patients at The Mayo Clinic on whom laryngectomy is performed are supplied with a satisfactory artificial larynx made by Dr. Sheard of the division of physics and biophysical research. It may be connected by means of a metal cup to the tracheal opening or if the patient is wearing a tracheotomy tube directly to this. Speech by this method has changed the mental attitude of these patients, and contrary to the general impression, most of them are able to return to their original occupation. Their morale is excellent.

#### CONCLUSIONS

The surgical treatment of carcinoma of the larynx compared to the treatment of carcinoma in general entails a low operative mortality (less than 1 per cent) and a high percentage of 5 year cures (64.5 per cent). Patients operated on for carcinoma of the larynx usually have a good outlook as regards speech. Almost all of the patients who have had a conservative operation develop useful voices and those requiring laryngectomy are able to talk by means of the pharyngeal muscles or an artificial larynx.

#### BIBLIOGRAPHY

1. COLLEGE, LIONEL, and FRANK ROYDON. An analysis of 126 cases of malignant disease of the

- upper air passages treated during a period of ten years, 1921-1930. *J Laryngol & Otol* 1932 xlvii, 161-187
2. CRILE, G. W. Laryngectomy for cancer. *Ann Surg* 1913, lvi, 164-177
  3. HARRIS, W. D. The Relative Value of Radiotherapy in the Treatment of Cancers of the Upper Air passages. London John Murray 1932
  4. JACKSON, CHEVALIER, and BARCOCK, W. W. Laryngectomy for carcinoma of the larynx. *Surg. Ciba. N Amer.*, 1931 xl, 1207-1227
  5. LEWIS, F. O. Laryngeal cancer: statistical report on five year cures. *Surg. Gynec. & Obst.*, 1933, lvi, 466-487
  6. LYCKE, R. C. Observations of a laryngologist. *J Am M. Ass.*, 1930, xc, 795-796
  7. MACKENZIE, J. E. Cancer of the larynx. *Arch Otol* 1926, iii, 203-23 305-337
  8. NEW, G. B., and FLETCHER, ELEANOR. The selection of treatment for carcinoma of the larynx. *J Am. M. Ass.* 1932, xcix, 1754-1757
  9. ORTOL, H. B. The diagnosis and treatment of malignant conditions of the laryngopharynx. Section on Laryngology, Otolaryngology and Rhinology. *Am. Med. Assn.*, pp. 53-61, 1931
  10. MULLIN, W. V. The diagnosis and treatment of cancer of the larynx. *Proc. Inter-State Post-Graduate Medical Assembly of North America*, pp. 198-200, 1931
- PORTMAN, GEORGE. The rôle of surgery in the modern X-ray treatment of cancer in the larynx. *Tr Am. Laryngol. Ass.* 1927, xlii, 90-93.
1. TAPPA, A. J. Quoted by Thomson.
  2. THOMSON, ST. CLAIR, and COLLEDGE, LYONEL. Cancer of the larynx. *Anglo-French Library of Medical and Biologic Science*, p. 244. London K. Paul, 1930

## SUPRAVAGINAL HYSTERECTOMY

A STATISTICAL SURVEY OF 1900 CASES WITH ESPECIAL REFERENCE TO THE LATER DEVELOPMENT OF CARCINOMA IN THE RETAINED CERVIX

RICHARD L. PEARSE M.D. BOSTON

From the Free Hospital for Women, Brookline, Massachusetts

THIS study was undertaken primarily to discover the incidence of carcinoma of the cervical stump following supravaginal hysterectomy. The series includes all the cases in which this operation was performed over a period of 26 years i.e., from 1900 to 1925 inclusive. The patients were traced by sending a questionnaire to the last available address. If this brought no answer a search was made through the directories of the living and the registry of deaths in the Massachusetts State House. Out-of-state patients were traced through the town clerk and local board of health. By means of the questionnaire an attempt was made to determine whether the patient had any vaginal discharge or bleeding, pain or symptoms of prolapse. All complaining of discharge or bleeding were requested to return for examination. Those with no complaints were considered well and examination was not advised. Of the patients living and well only those who could be traced for at least 5 years were considered suitable for the purpose of this study. Of the 1900 consecutive cases, then, 860 or about 45 per cent, could not be traced for more than 5 years. Of the remaining 34 had died following operation, 192 had died of causes other than carcinoma of the cervix, 802 were living and well 5 to 25 years after operation, 2 had died of cancer of the cervix which was known to be present at the time of operation (vi), 2 had unsuspected cancer of the cervix at the time of operation and 8 are known to have developed later cancer of the cervix.

At the Free Hospital for Women the technique of supravaginal hysterectomy has been practically standardized. With the exception of 16 cases prior to October, 1902 in which the cervix was not suspended by the round and broad ligaments all were operated upon according to the method described by Graves in his *Gynecology*. Bilateral salpingo-oophorec-

tomy was included in all but 18 cases in these 1 ovary was retained.

The pathological conditions which led to hysterectomy are classified in Table I. This is possible because all except 6 specimens have been examined grossly and microscopically. These 6 have been classified by a consideration of the operative notes and other available data. The ages by decades at which operation was performed are tabulated in Table II. About 10 per cent of the total series had passed the menopause. Table III shows the operative procedures combined with supravaginal hysterectomy.

There were 34 operative deaths, a mortality of 1.7 per cent. This figure agrees exactly with that of Bartlett and Simmons for a larger series of supravaginal hysterectomies performed at the Free Hospital for Women (1). Von Graff has quoted the following percent ages for operative mortality:

	Total hysterec- tomy	Supra- vaginal hysterec- tomy
Weibel	3.35	4.25
Americ	3.8	7
Shaw	5.0	3.09
Follenio and Faulkner	4.1	4.4
Mason	1.1	1.1
Mayer		

Burch and Burch in a small series reported a mortality of 4.2 per cent for supravaginal hysterectomy and 3.1 per cent for complete hysterectomy. Bartlett and Simmons gave 7.9 per cent as the operative mortality for all cases of total hysterectomy at the Free Hospital for Women between 1902 and 1932. Malignancy was the cause of operation in 122 cases and for these the mortality was 13.9 per cent. One hundred thirty-seven complete hysterectomies for non malignant conditions resulted in a mortality of 5.1 per cent. Many of these patients were bad operative risks, especially those with malignant disease and the operations were technically difficult. These cases differ considerably from those selected for

TABLE I.—PATHOLOGICAL CONDITIONS IN 1900  
SUPRAVAGINAL HYSTERECTOMIES

	Total	Number with satisfactory follow-ups
Acute pelvic inflammatory disease	64	37
Chronic pelvic inflammatory disease	179	104
Tuberculous pelvic inflammation	26	4
Fibroids	3	180
Fibroids complicated by pelvic inflammatory disease	449	234
Prolapsus	30	79
Protrusion	70	190
Endometriosis	8	12
Adenomyosis	2	5
Adenocarcinoma of the endometrium	2	12
Pseudocarcinoma cystic corpus of the ovary	26	10
Serous cystadenoma of the ovary	9	2
Papillary cystadenoma (benign) of the ovary	9	—
Papillary cystadenoma (malignant) of the ovary	—	7
Dermoid cyst of the ovary	3	9
Fibroma of the ovary	7	1
Carcinoma of the ovary	1	1
Dysfunctional bleeding	50	21
Epilepsy	6	4
Ectopic pregnancy	13	7
Pregnancy complicated by fibroids	2	1
Pregnancy	4	4
Excessive uterine	—	—
Uterine injury	1	6
Unconjugated uterus	—	—
Stenosis of the uterus	—	—
Stenosis of the cervix	—	—
Adenocarcinoma of the tube	—	—
Miscellaneous (insufficient data)	30	—
Total	1,000	1,200

\*Three patients were known to have carcinoma of the cervix. Supravaginal hysterectomy was performed in preparation for use of the Percy cautery. They are included to maintain the integrity of the series.

elective total hysterectomy at present. The causes of death according to the clinical diagnosis are listed as follows:

Pulmonary embolism (three occurred on the operating table)	8
Shock	7
Cardiac failure	—
Pneumonia	3
Peritonitis	2
Intestinal obstruction	3
Nephritis	—
Septicemia	—
Exhaustion	—
Liver	—
Purpura hemorrhagica	—

The case dying of exhaustion was a 74 year old woman who died of no apparent cause a month following operation for bilateral ovarian cysts and multiple fibroids. The case of purpura was a woman of 40 who prior to operation had had no symptoms or history of purpura. Following operation for large fibroids she bled from her wound and failed to respond to several transfusions. Parotitis developed and death occurred after 11 days.

But 2 autopsies were obtained. One was limited to an abdominal incision. The patient was a 43 year old woman who died 2 hours following a difficult operation for multiple fibroids and chronic pelvic inflammation. A

TABLE II.—AGES BY DECADES AT WHICH  
HYSTERECTOMY WAS PERFORMED

Years	Total	Number with satisfactory follow-ups
0-19	8	—
20-29	34	77
30-39	621	299
40-49	746	491
50-59	215	120
60-69	43	23
70+	8	4
Total	1,695	1,014
Had passed the menopause	30	11

TABLE III.—OPERATIONS PERFORMED WITH  
SUPRAVAGINAL HYSTERECTOMY

	Total	Number with satisfactory follow-ups
Plastic operation on vagina, or cervix, or both.	174	807
Apoplastomy	21	158
Excision of cervical stump to extreme abdominal wall	—	—
Ovarian transplantation	176	114
Proctostomy	63	30
Myometrium operation	13	13
Excision of sigmoid	14	8
Excision of bladder	1	—
Excision of vesicovaginal fistula.	—	—
Excision of postuterine fibromatosis	1	—

diagnosis of shock had been made. The ureters and rectum were intact. A complete postmortem examination was allowed on the other case. Probably death was due to either although clinically the diagnosis had been myocarditis. The patient was 36 years old her blood pressure was 134/80. Death occurred on the operating table at the completion of operation for multiple fibroids and chronic pelvic inflammation. The only anatomic findings were slight chronic and acute infectious lesions of the kidney.

In Table IV are listed the causes of death and the time intervals following operation of the 192 patients who died of diseases other than carcinoma of the cervical stump. Although the data on the last 6 cases in the table are incomplete cancer of the cervix can safely be excluded.

Of the 802 patients living and well 5 or more years after operation, 542 had received no treatment of their cervixes (165 had never been pregnant). Ninety-eight of these, 18 per cent, complained of vaginal discharge. Of the 260 remaining patients (12 had never been pregnant) who received cervical treatment (cauterization—37 trachelorrhaphy—85 amputation—121 excision of polyp—10, coring out

TABLE IV—DEATHS DUE TO CAUSES OTHER THAN CARCINOMA OF THE CERVICAL STUMP

	Less than 5 yrs P.O.	Five to 9 yrs P.O.	Ten to 19 yrs P.O.	Twenty to 30 yrs P.O.
Arteriosclerosis (including cerebral hemorrhage)	7	4	5	4
Heart disease	6	6	9	
Nephritis (including uremia)			3	
Pneumonia	7	5	6	
Diabetes		3		
Carcinoma of stomach		5	5	
Carcinoma of liver				
Carcinoma of breast		3		
Carcinoma of rectum				
Carcinoma of pancreas				
Carcinoma of urinary bladder				
Carcinoma of urethra				
Carcinoma of ovary (recurrent)	5			
Carcinoma of endometrium (recurrent)	6			
Carcinomatosis (of gastrointestinal origin)			1	
Epilepsy				
Encephalitis				
Dementia praecox				
General paresis				
Brain tumor				
Syringomyelia				
Strangulated hernia				
Cirrhosis of the liver				

TABLE IV—(CONT)

	Less than 5 yrs P.O.	Five to 9 yrs P.O.	Ten to 19 yrs P.O.	Twenty to 30 yrs P.O.
Intestinal obstruction		1		
Intestinal ulcers and diverticula				
Pyloric stenosis				
Gall-bladder disease				
Pulmonary tuberculosis		1		
Abdominal tuberculosis	3			
Septicemia				
Endocarditis				
Streptococcus meningitis				
Acute appendicitis				
Periculous anemia		3		
Hodgkins disease				
Splenomegaly				
Exophthalmic goiter				
Acute bronchitis				
Pulmonary embolism				
Sarcoma of uterus (re current)				
Postrectal fibrosarcoma				
Sarcoma of breast				
Sarcoma of pelvis				
Hemocoele				
Scicide				
Accidental injuries (burns, etc.)				
Senility			1	
Cause not definitely known	4			

from above—7) 33 or 12.6 per cent complained of discharge. A vaginitis was the usual finding in these cases. Masson has reported 45 cases of vaginal discharge following supravaginal hysterectomy.

There were 60 patients living and well 5 or more years after plastica and hysterectomy for prolapse. None complained of symptoms suggesting recurrence. Among 105 patients operated upon 5 or more years previously for frank procidentia, however, 12, 11.4 per cent, stated that their symptoms had returned. In 9 of these the cervix had been fixed to the anterior abdominal wall. No matter what treatment is employed in procidentia, prolapse may recur because of the constitutional

tendency of the tissues in these cases to stretch. In only 6 instances were symptoms of prolapse a complaint among the 638 patients operated upon for causes other than prolapse and procidentia. The cervical stump was usually held so high in those cases seen that examination of it was difficult.

Concerning the incidence of carcinoma in the cervical stump following supravaginal hysterectomy, 8 patients are definitely known to have developed the disease. This figure represents 1 per cent of the 802 patients alive and well 5 or more years after hysterectomy. Since 122 of the 192 cases dying of causes other than cervical cancer survived hysterectomy for 5 to 20+ years, thus allowing





Fig. 1

sufficient time for cancer of the cervix to develop it seems fair to consider the figure of incidence somewhat less than 1 per cent.

Monod states that the incidence of carcinoma of the cervical stump is higher than that in non-operated women. Stein on the other hand feels that the incidence is no higher. The statistics of a few authors are tabulated (3).

	Total	Cases of stump carcinoma	Per cent
Tanner	1,744		
Albrecht	4,918	7	4
Scudder	263		
Townsend	264		14
Hochman	1,111	3	17
Moys (")	3,485	1	

Schottlaender, Herbert, Spencer and Noble (15, 20) examined 900 uteri removed totally by operation and in 2 per cent found microscopic evidence of cervical malignancy when no gross or clinical evidence was present.

Fibroids have long been considered a predisposing factor in malignant degeneration of the stump (8, 11, 16, 18). In this series the

largest group is made up of cases of fibroids i.e. 39.5 per cent of the operations were performed either for fibroids or fibroids complicated by pelvic inflammation. Of the 410 patients in this group satisfactorily traced carcinoma of the stump developed in 4 i.e. 0.97 per cent. On the other hand of 201 cases of pelvic inflammatory disease 4 are known to have developed stump carcinoma—1.99 per cent. In other words, the incidence of cervical carcinoma in this series is over twice as great among patients with pelvic inflammation as among those with fibroids.

Davis and Ferry have each reported carcinoma of the cervix developing 5 and 6 months, respectively after supravaginal hysterectomy. At the time of operation both cases were negative clinically. The summaries below indicate that the development of the disease may be much more slow. The first 2 cases are considered to have been missed at operation.

**CASE 1.** Patient aged 38 years complained of lumbar backache, bearing down, and dysuria. She had had one labor. Catamenia was normal. Examination disclosed a lacerated perineum and cervix, cystocele, retroversion and prolapse. Operation consisted in dilatation and curettage, cauterization of the cervix, trachelorrhaphy, anterior colporrhaphy with excision of urethral cyst, supravaginal hysterectomy and appendectomy. Convalescence was uneventful. Pathological report chronic cervicitis, chronic salpingitis and hydrosalpinx, chronic appendicitis. Four years and 7 months later the patient was examined because of slight flowing which had occurred 3 months and 4 days previously. The cervix was enlarged and indurated. Biopsy report squamous carcinoma. A re-examination of the specimen removed by trachelorrhaphy disclosed early carcinoma (see Fig. 1). The patient was treated with radium and on examination one year later was found to have an advanced recurrence.

**CASE 2.** Patient aged 55 years, complained of continuous flowing of 3 months duration previous to which her catamenia had been normal. She had had 2 labors. Examination disclosed a large multiple fibroid uterus and tender mass in pouch of Douglas. Operation consisted in lysis of adhesions, supravaginal hysterectomy, appendectomy. Convalescence was stormy. Pathological report endometrial hyperplasia, multiple fibroids, chronic salpingitis, chronic periappendicitis. A year and 7 months later the patient complained of irregular flowing of 7 months duration. Examination disclosed a tumor of the cervical stump, biopsy squamous carcinoma. Radium was applied and the patient was alive and well 5 years and 11 months later.



Fig. 2

The following 8 cases are almost undoubtedly examples of true malignant degeneration of the cervical stump

**CASE 1.** Patient aged 31 years complained of lower abdominal pain and leucorrhoea of 11 years duration—unrelieved by previous right salpingo-oophorectomy. She had had two labors. Menstruation was normal. Examination revealed moderate vaginal relaxation, tender mass in left vault. Operation consisted in anterior colporrhaphy, perineorrhaphy, supravaginal hysterectomy, appendectomy. Convalescence was complicated by pelvic sepsis. Pathological report: multiple fibroids, chronic salpingitis, chronic oophoritis, chronic appendicitis. Thirteen years and 10 months afterward the patient complained of a brown, blood tinged discharge of 3 months duration. Clinically the cervix was negative. A biopsy was not considered malignant. Unfortunately the section that survives today is only a piece of fibrous tissue without a trace of epithelium. Nineteen years and 11 months after operation and 6 years and 1 month after biopsy the patient appeared in another Boston hospital. A diagnosis of moderately advanced squamous carcinoma of the cervix of medium malignancy was made. She was treated with radium and died of the disease one year and 7 months later.

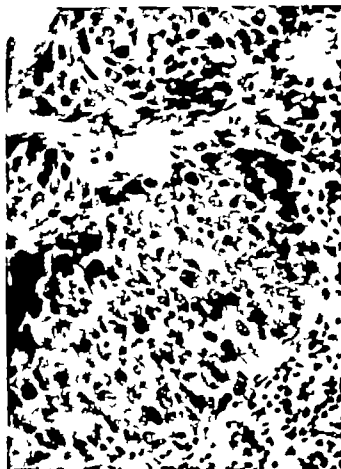


Fig. 3. High power taken from Figure 1

**CASE 2.** Patient aged 41 years complained of bearing down sensation in left lower abdomen, worse with menstruation. She had had 2 labors. Catamenia were normal except for pain. Examination revealed an irregularly enlarged uterus. Operation consisted in supravaginal hysterectomy, appendectomy. Convalescence was uneventful. Pathological report: multiple fibroids, chronic salpingitis, hydrosalpinx. Eight years and 6 months later the patient was seen because of a bloody discharge of a year's duration. Biopsy: squamous carcinoma. Radium was applied; she was well 6 years and 8 months later.

**CASE 3.** Patient aged 38 years, had complained of lower abdominal pain, nausea and vomiting for 5 months, since the birth of her fifth child. Menstruation was normal. Examination revealed a hard, irregular mass filling Douglas pouch. After a short period of conservative treatment, supravaginal hysterectomy and vaginal drainage were performed. Convalescence was complicated by wound sepsis. Pathological report: tubo-ovarian abscess. After 17 years and 6 months the patient was readmitted because of staining and yellow discharge for a year. Her cervix was large and firm. Microscopic examination showed squamous carcinoma. She was treated with radium and has been untraceable since.

**CASE 4.** Patient aged 34 years, had complained of vaginal discharge and labor like pains for 4 years.

following a period of painful micturition—unrelieved by right salpingo-oophorectomy 3 years previously. She had had 2 labors. Catamenia were normal. There were swelling and tenderness in the left vault. Operation consisted in dilatation and curettage trachelorrhaphy supravaginal hysterectomy. Recovery was satisfactory. Pathological report acute endometritis, chronic cervicitis, salpingitis and oophoritis. Twelve years and 7 months later a blood tinged discharge of 3 weeks duration brought the patient to another Boston hospital, where carcinoma of the cervix with vaginal involvement was found. Microscopic diagnosis squamous carcinoma. Radiation was applied. She was well after 6 months but has since been untraceable. Subsequent study of the trachelorrhaphy specimen revealed areas very suspicious of early malignancy (Figs 2 and 3).

CASE 5. Patient aged 43 years, had complained of vaginal discharge and blood for 3 months. She had had one labor. Three years before unilateral salpingo-oophorectomy had been performed since which time there had been no menses. Adherent masses could be felt in the pelvis. Operation consisted in supravaginal hysterectomy. Pathological report chronic salpingitis, cystic ovary chronic endometritis. Seven years and 10 months later the patient returned because of bleeding. Her cervix was large and indurated. biopsy showed squamous carcinoma. The cervical stump was excised. One year and 3 months afterward she died of intestinal obstruction, due presumably to a recurrence.

CASE 6. Patient aged 34 years, had never been pregnant. She complained of irregular and profuse catamenia—one year lower abdominal and sacral pain—6 weeks. Her uterus was large she was flowing profusely. Operation consisted in dilatation and curettage, supravaginal hysterectomy and appendectomy. Pathological report multiple fibroids, chronic salpingitis, obliterated appendix. Seven years and 10 months later she was seen because of bleeding. There was an irregular growth in the cervix which bled easily. Treatment was strongly urged but refused. The death certificate stated that she had died of cervical cancer 1 year and 3 months afterward. There was no biopsy of this tumor.

CASE 7. Patient aged 34 years, complained of pain in right side of abdomen. Labors one. Catamenia were normal. Examination revealed a lacerated perineum and cervix, tenderness in right vault. Operation consisted in supravaginal hysterectomy appendectomy. Pathological diagnosis acute endometritis, acute salpingitis, ovarian abscess. Six years and 3 months later she was seen because of a year's flowing. The cervix was indurated biopsy proved squamous carcinoma. The tumor was irradiated at another hospital death occurred in 6 months.

CASE 8. Patient aged 40 years had never been pregnant. She complained of pain in the left groin. Catamenia were normal. Examination revealed multiple fibroids. Operation consisted in supravaginal hysterectomy and appendectomy. Pathological report multiple fibroids, chronic salpingitis,

and appendicitis. Six years and 3 months later after nearly 2 years of bleeding she was found to have a large indurated cervix which contained squamous carcinoma. Coliotomy was performed and the Percy cautery employed. She died, apparently of embolism 14 days after operation.

That 2 of the 8 patients mentioned had never been pregnant seems exceptional. It is noteworthy that only one of these 8 cases had had a trachelorrhaphy and that a re-examination of the section over 12 years later when there was cancer clinically showed a very suspicious area. In only one instance (Case 8) did symptoms leading to the finding of cancer start earlier than 5 years after hysterectomy. It is conceivable that very early cancer may have been present in this patient at the time of operation especially when one considers that the first of the 2 missed cases of cervical carcinoma did not have symptoms until more than 4 years after a tumor bearing specimen had been excised. Beckman observed an erosion of the cervix develop into cancer over the course of 5 years.

#### SUMMARY

Nineteen hundred consecutive cases of supravaginal hysterectomy performed between 1900 and 1925 (inclusive) have been reviewed. There were 34 operative deaths, a mortality of 1.7 per cent. One hundred and ninety two patients died later of causes other than carcinoma of the cervical stump. Two died of cancer of the cervix which was known to be present at the time of operation. Two had unsuspected cervical cancer at the time of operation. Eight hundred and sixty patients could not be traced for more than 5 years. Of the remaining 810 followed for 5 to 25 years, 8 are known to have developed carcinoma of the stump an incidence of about 1 per cent.

Eighteen per cent of the women whose cervixes had not been treated stated that they had vaginal discharge. Of those whose cervixes had been treated 12.6 per cent admitted having more or less discharge. Most often the cause of the discharge was found to be a vaginitis.

Symptoms suggesting prolapse of the cervical stump occurred in 11.4 per cent of the cases that had had procidentia and in 0.9 per cent of all others.

The incidence of stump carcinoma in cases that previously had fibroids is compared with that in cases of previous pelvic inflammation and found to be less than half as great. In no case of previous prolapse or procidentia was carcinoma of the retained portion of the cervix found to have occurred.

The cases of cervical cancer apparently missed at the time of hysterectomy and those developing the disease later are briefly summarized.

### CONCLUSIONS

Unless the mortality from total hysterectomy can be shown to be the same or less than that for supravaginal hysterectomy in the same type of case, the possibility of later cancer of the cervix should not be considered an indication for complete extirpation.

Carcinoma of the cervix may be a very slowly progressing disease not giving symptoms of its presence until over 4 years after its onset. Furthermore in this series, it developed later only in cases of previous pelvic inflammation or fibroids and not once in cases of previous prolapse or procidentia.

Before supravaginal hysterectomy is performed the cervix in every instance should be carefully examined. Biopsy should be made on the slightest suspicion. Lacerations and erosions should be repaired or cauterized.

### BIBLIOGRAPHY

1. BARTLETT M. E., and SIMMONS F. A. Jr. Mortality factors in gynecology. *Surg. Gynec. & Obst.* 1932 xl 777.
2. BECKMAN W. Einige klinische Beobachtungen ueber Uteruscarcinom. *Ztschr f. Geburtsh. u. Gynaek.* 1907, xlv 402.
3. BRADSCOMB, LOUISE. Occurrence of carcinoma in the uterine stump after supravaginal hysterectomy. *Am. J. Obst. & Gynec.* 1930, xx 66.
4. BURCH, L. E. and BURCH J. C. Mortality in hysterectomy operations. *Am. J. Obst. & Gynec.* 1931 xxi, 704.
5. CASEMAN B. Z. The value of cauterization of the cervix before hysterectomy. *Am. J. Obst. & Gynec.* 1926 xii 591.
6. DAVIS, L. Carcinoma of the cervical stump. Boston M. & S. J. 1923 cxxxviii, 304.
7. FERRY G. L'épithélioma du col restant après hystérectomie subtotale par fibrome. *Bull. et mém. Soc. nat. de chir.* 1930 lvi 592.
8. FRANK R. T. Carcinoma of the cervical stump metastasis in the vermiform appendix. *Surg., Gynec. & Obst.* 1923, xxxv 334.
9. ISBRUCH F. Cancer in stump after supravaginal amputation. *Zentralbl. f. Gynaek.* 1926, l 1771. (Reviewed J. Am. M. Ass. 1926 lxxxvii, 715.)
10. LEONARD V. N. On the development of malignant disease of the cervical stump after supravaginal hysterectomy. *Ann. Surg.* 1913 lviii, 373.
11. MARSON J. C. Total versus subtotal abdominal hysterectomy. *Am. J. Obst. & Gynec.* 1927, xiv 486.
12. MAYO C. H. and MAYO C. H., JR. Carcinoma of the cervical stump following subtotal hysterectomy. *Ann. Surg.* 1931 xciii 1215.
13. MONTGOMERY R. La cancerization du col après hystérectomie subtotale. *Bruxelles méd.* 1930 x, 1087.
14. PIRKMAN J. La question de la cancerization du néoplasme cervical après hystérectomie subtotale. *Strahl. méd.* 1930, ix, 653.
15. POLAK, J. O. Total hysterectomy in fibroid tumors of the uterus. *J. Am. M. Ass.* 1920, lxxxv 579.
16. POLLOSSON E. A propos de l'épithélioma du col restant après hystérectomie subtotale. *Lyon chir.* 1930 xxvii, 697.
17. REDER, R. Lesions of the cervical stump of the supra vaginally ablated uterus. *Am. J. Obst. & Gynec.* 1924 vii, 173.
18. SÉBASTIEN J. Le cancer du col restant après l'hystérectomie subtotale. *Presse méd.* 1931 xxxix, 1042.
19. SPENCER, H. R. Remarks on total abdominal hysterectomy for myoma of the uterus. *Brit. M. J.* 1932 i 1137.
20. STEIN, A. Cervical stump carcinoma following supravaginal hysterectomy. *Am. J. Surg.* 1928 v, 340.
21. VON GRAFF, E. Abdominal total hysterectomy. *Am. J. Obst. & Gynec.* 1932, xxiii, 195.
22. ZAMPA G. L'épithélioma del collo uterino dopo l'histerectomia subtotale per fibromioma. *Ist. clin.,* 1930 xxxvii, 745.

## SPINAL ANÆSTHESIA

## AN EXPERIMENTAL STUDY

KENNETH WADE THOMPSON, M.D. BOSTON

Harvey Cushing Fellow in Surgery Peter Bent Brigham Hospital

TWO alarming complications of spinal anesthesia, respiratory failure and vasomotor collapse, have played an important part in retarding the use of this valuable method. Treatment of these reactions has been based upon the theory that the anesthetic drug causes a paralysis of sympathetic vasomotor control and that respiratory paralysis is the result of bulbar anemia (Evans). The existing experimental and clinical data are confusing however and do not clearly support this view of the phenomena involved.

The experimental evidence indicates quite clearly that the fall of blood pressure is caused by paralysis of the sympathetic fibers of the spinal root filaments. Smith and Porter in one of the earliest experimental studies of spinal anesthesia concluded that the fall of blood pressure was due to a paralysis of the splanchnic control. They found no evidence that the fall of blood pressure was because of 'paralysis of the bulbar vasomotor center.' Most of their observations have been confirmed by Schill and Ziegner and by Ferguson and North. The latter emphasize that it is not the splanchnic region alone that is affected but that all the sympathetic fibers are involved in the area anesthetized.

On the other hand another group of investigators ascribe the fall of blood pressure to cardiac failure which results when paralysis of the intercostal nerves interferes with normal chest expansion and diaphragmatic excursion and causes a damming back of venous blood in the right heart and its tributaries (Bower, Clark, Wagoner and Burns).

The cause of respiratory failure is not clear. Ferguson and North report that in their experiments with spinal anesthesia there was first a paralysis of the thoracic cage followed by a paralysis of the diaphragm as the level of anesthesia rose. These observers state that their results conform with the findings of Bower, Clark and Wagoner who noted after

cervical injections of atovaline a depression of respiration followed by a fall of blood pressure and who concluded that alterations of blood pressure in spinal anesthesia are secondary to a central respiratory depression. However Ferguson and North do not admit that the explanation for all the alterations lies primarily in bulbar respiratory paralysis, except in those cases in which the drug reaches the upper levels in high concentration.

Cotul and Standard injected procaine into the cisterna magna of dogs, and the phenomena produced they attribute to paralysis of the vital centers. Since respiratory paralysis occurred first in these instances they presume that this center may be more exposed to the action of the drug than the vasomotor center.

The relative resistance of motor nerve fibers to the action of local anesthesia has been known for more than 30 years (Hunt 9). More recently Gasser and Erlanger have shown that phrenic fibers are especially resistant to narcosis. The practical application of this principle is seen when anesthesia of the face and scalp without paralysis of respiration follows the intraspinal injection of procaine. The circulation which may fall under these circumstances can be maintained by suitable stimulants. The successful use of spinal anesthesia at high levels appears to depend therefore on the relative resistance of the phrenic fibers to narcosis, and on the maintenance of an adequate circulation. However the precautions taken in the clinic based upon this knowledge have not prevented fatal accidents. Such accidents have been charged against a 'primary respiratory failure or central action' without adequate explanation of the phenomena.<sup>1</sup>

A certain number of fatalities appear to have followed an actual intravascular injection of the drug, but a "bloody tap" has been made in every instance and Kyprianou showed that the toxicity of procaine is very great if it is injected rapidly into one, but large amounts may be introduced intravenously if administered slowly. It is assumed that occasionally in spinal anesthesia, due to faulty technique the patient may be subject to this type of reaction.

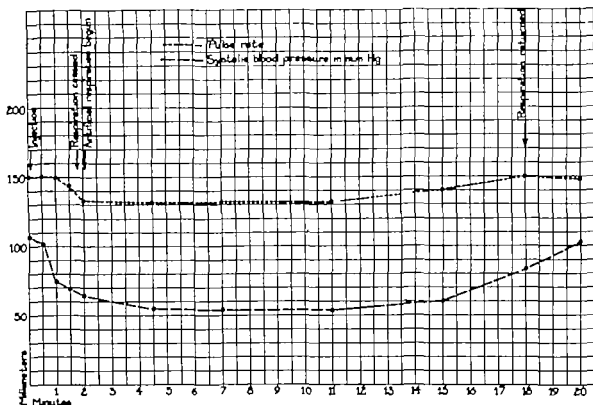


Fig. 1. Intraventricular injection of 25 milligrams procaine. Basal paraldehyde narcosis.

It is evident that further observations on the relation of respiration to changes in blood pressure are needed before unfavorable reactions can be adequately interpreted. The present report is the result of studies of the phenomena of spinal anesthesia the first of which dealt with a comparison of the effect on respiration and blood pressure of injections of procaine into the ventricular, cisternal and lumbar cerebrospinal spaces of dogs. These experiments led to other studies such as the recovery from procaine narcosis of an isolated nerve, changes in respiration and in cerebrospinal fluid pressure produced before and after the induction of spinal anesthesia by drugs which cause a rise or fall of blood pressure<sup>1</sup> and a test upon the vital centers of an intact animal with cisternal fluid obtained from an animal with respiratory failure produced by spinal anesthesia.

#### PREPARATION

Large dogs under basal anesthesia were used for these experiments. Cannulae were inserted into the carotid artery and the jugu-

lar and femoral veins the first two for tracings of pulse and blood pressure and the latter for the intravenous injection of drugs. One vagus nerve was exposed for stimulation. Artificial respiration was maintained by means of a compressed air respiration machine and a tracheal cannula. Ventricular injections were made through a 'brain needle' after a preliminary burr hole was made. The needle was left in place after injections to avoid leakage from the tract of the needle. Determinations of cisternal pressure were made by puncture of the cisterna magna with a blunt No. 18 gauge needle which was connected to a U tube filled with Ringer's solution. The lumbar dura was exposed by laminectomy so that injections could be made in this region through a No. 23 gauge needle inserted under vision. It was found that leakage was less apt to occur if this needle was inserted obliquely and left in place after injections.

Basal paraldehyde anesthesia<sup>2</sup> supplemented by ether was used in all but two experiments. For these two animals sodium barbital<sup>3</sup> was used parenterally in one and

<sup>1</sup> The drugs used for this purpose were epinephrine, ephedrine, amyl nitrite, acetylcholine and physostigmine of choline. These last two drugs were obtained from Dr. Reid H. and prepared by R. W. Renshaw (10).

<sup>2</sup> Dose—1.7 c.c.m. per kgm., by stomach tube.

<sup>3</sup> Dose—0.350 gm. per kgm. parenterally.

intravenously in the other. In anesthesia with paraldehyde the blood pressure and pulse rate were elevated while with sodium barbital the blood pressure and pulse rate were considerably lower. After the administration of paraldehyde the respirations were slow and deep and were quickly affected by varying conditions. With sodium barbital however the respirations were not only slower and more feeble but they responded less rapidly to the conditions of the experiment. Paraldehyde was chosen for anesthesia because of its relatively low toxicity. A very depressing basal anesthesia would undoubtedly confuse the responses of the respiratory center and enhance other depressor effects.

#### VENTRICULAR INJECTION OF PROCAINE (FIG 1)

Injections of procaine in doses of from 10 to 200 milligrams dissolved in 1 cubic centimeter of Ringer's solution were made into the lateral ventricle of dogs. Ten seconds was the usual time consumed by the injection. Ten milligrams failed to cause respiratory paralysis but 25 mgm. or more caused cessation of respiration in from 1 to 1½ minutes. The movements of respiration ceased suddenly without definite preliminary change although occasionally it seemed that thoracic respiration was paralyzed just before diaphragmatic breathing ceased. The return of respiration was quite sudden 15 to 30 minutes after the injection had been made and the first spontaneous respirations were often of a peculiar type usually completely co-ordinated acts with facial cervical and thoracic muscles moving in concert with the diaphragm. In a few experiments in which the basal anesthesia was light the first spontaneous respirations resembled great yawns passing on to deep gasps and to a hypernoea resembling that which follows carbon dioxide inhalation. Respiration became normal within approximately 5 minutes.

The ventricular injection of procaine also caused a slowing of the pulse rate and a fall of blood pressure both phenomena beginning 10 to 30 seconds after the injection and reaching their maximum effect within about 2 minutes so that at the time respirations became

paralyzed the pulse rate had slowed 20 to 40 points, and the blood pressure had fallen from over 100 millimeters mercury systolic to 40 to 70 millimeters mercury. After remaining at this low level for from 5 to 10 minutes, depending upon the size of the dose the pulse rate and blood pressure rose gradually to normal during a period of from 4 to 10 minutes, and when the systolic pressure had almost returned to normal respiration commenced. The entire process consumed at times only 20 minutes and the reactions could be repeated again and again in the same animal. The 10 to 15 milligram doses of procaine produced a slight vasomotor change consisting of a moderate fall of blood pressure and a slowing of the pulse with a slight alteration of the quality of the respirations without actual paralysis.

#### CISTERNAL INJECTIONS OF PROCAINE

One hundred and fifty milligrams of procaine dissolved in 1 cubic centimeter of Ringer's solution was injected into the cisterna magna. Respirations ceased within 1 minute. Artificial respiration was immediately started and the animal was placed in deep Trendelenburg position in anticipation of a marked fall in blood pressure. The pulse rate slowed considerably and the blood pressure began to fall descending to the low level of about one third normal during the 10 minutes following injections. Asphyxia had no part in these changes as artificial respiration was promptly and adequately maintained. After 1½ to 2 hours feeble spontaneous respirations and a rise in blood pressure were noted progressing so that in about 2½ hours artificial respiration could be stopped. However the animal could not be removed from Trendelenburg position to the horizontal without a drop in blood pressure and a cessation of respiration requiring further artificial respiration for about one-half hour. Postural changes at this stage continued to cause some fall in blood pressure.

#### LUMBAR INJECTION OF PROCAINE (FIG 2)

A definite train of events took place fairly regularly upon the injection of 150 milligrams

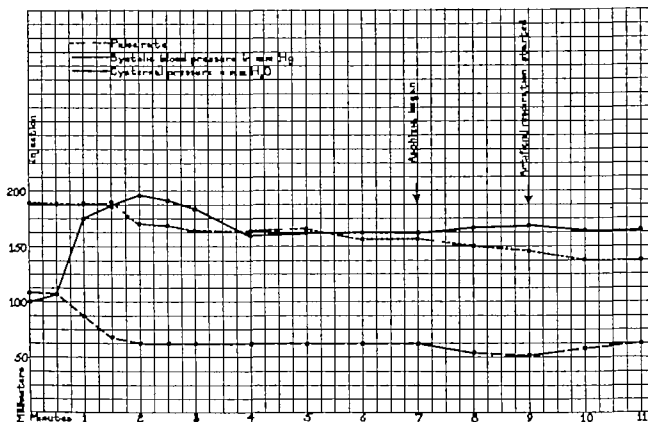


Fig. 2. Intraspinal injection (lumbar) of 150 milligrams of procaine. Basal paraldehyde narcosis.

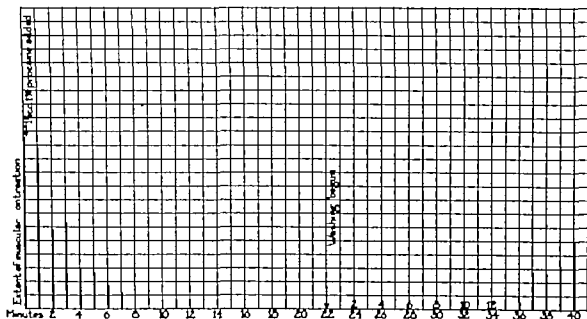


Fig. 3. Paralysis and recovery of frog nerve muscle preparation following exposure of nerve to 1 per cent procaine plus epinephrine.



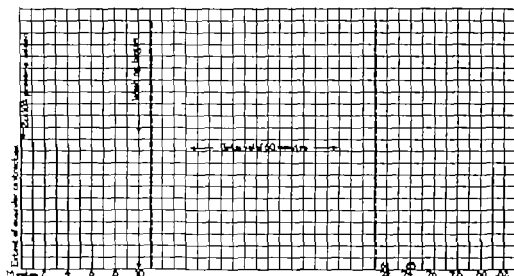


Fig. 4. Paralysis and recovery of frog nerve muscle preparation following exposure of nerve to 10 per cent procaine plus epinephrine.

of procaine dissolved in 1 cubic centimeter of Ringer's solution into the lumbar cerebrospinal spaces. Within 20 to 60 seconds the blood pressure dropped to one third its former level and toward the end of this drop the pulse slowed to two-thirds its former rate. Respirations in this short time became purely abdominal in type and the thorax was seen to be paralyzed expanding on expiration instead of on inspiration as is normal. The movement of tidal air gradually failed so that within 7 to 10 minutes after the injection of the drug cyanosis was marked and respiration had totally ceased. Cardiac action frequently failed before diaphragmatic movement completely stopped and often the animal could not be saved if artificial respiration were not begun early. Immediately after starting artificial respiration and placing the animal in marked Trendelenburg position the color improved and the animal remained in this condition of low pulse and blood pressure for  $1\frac{1}{2}$  to 2 hours, after which time a gradual rise of blood pressure, followed by feeble beginning of spontaneous respiration occurred and increased so that it was safe to cease artificial respiration at the end of 2 to  $2\frac{1}{2}$  hours. However the state of the animal's vasomotor system was so unstable that removal from marked Trendelenburg position

to the horizontal caused serious collapse of circulation with cessation of respiration requiring for recovery a marked Trendelenburg position and artificial respiration for another half hour.

An interesting complication occurred after lumbar injection in 2 of the animals under observation. In both these instances all was going well after the usual reaction when irregularity of the cardiac rhythm developed. At first, it was transient and the chart showed merely occasional effects resembling heart block. The dropped beats became so frequent, however that in the first instance almost a total cessation of action occurred and the chart showed only minute fibrillary contractions with the blood pressure at zero. Epinephrine in repeated doses was given and this first animal was finally saved although repeated doses of epinephrine at intervals of about 15 minutes were necessary in order to break up recurrences of the phenomenon. The same irregularity was seen at another time while waiting for recovery of an animal from spinal anesthesia. Preparation had been made, however to administer epinephrine at the first sign of dropped beat so that there might be less danger of a fatality. This complication of cardiac action might have occurred in other experiments were it not for

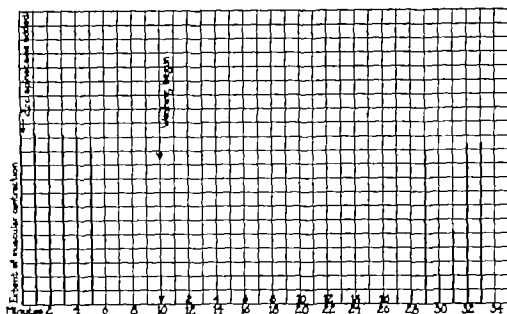


Fig. 5. Paralysis and recovery of frog nerve muscle preparation following exposure of nerve to spinocaine

the fact that in most of them epinephrine was used for determinations of alterations of cisternal pressure. The origin of the phenomenon was not investigated. It appeared after a long period of low blood pressure and slow pulse although no cyanosis was present.

#### RÉSUMÉ

The *ventricular injection* of procaine resulted in a paralysis of the central respiratory and vasomotor mechanisms. Immediately after the injection was made blood pressure and pulse rate decreased and respiration suddenly ceased. All of these functions recovered rather rapidly as co-ordinated processes. Smaller doses of the drug caused comparable effects (Fig. 1).

The *cisternal injection* of procaine resulted in an immediate cessation of respiration which was followed by a slowing of the pulse rate and a fall of blood pressure. Recovery was very slow and there was evidence of lack of co-ordinated vasomotor and respiratory responses.

The *lumbar injection* resulted in an immediate fall of blood pressure, an apparent paralysis of intercostal muscles, a slowing of the pulse rate, and a gradual failure of diaphragmatic respiration. The order of events was roughly the reverse of that seen after cisternal injection. Recovery was prolonged

with lack of co-ordinated responses suggesting a similar incomplete recovery of the parts involved.

The obvious interpretation of these results was that the central mechanism may recover rapidly from procaine paralysis presumably due to more adequate blood supply and the outward flow of cerebrospinal fluid from the choroid plexus of the ventricles, on the other hand when neurological units beyond the central mechanism are involved as in cisternal and lumbar injections, a different set of results appeared. It seemed probable that the difference lay in the fact that under the latter set of circumstances nerve filaments are involved which lie in a slowly changing cerebrospinal fluid medium. The procaine used in the latter experiments was concentrated enough to paralyze all types of fibers with which it came in contact and it was thus impossible to determine whether the paralysis of respiration following cisternal injection was due to paralysis of the phrenic filaments alone or whether the central paths of respiratory impulses were involved as well. Likewise the respiratory failure produced by the lumbar injection may have been due either to the action of the drug on the phrenic filaments or the center or to the effect of a collapse of circulation with resultant bulbar anemia.

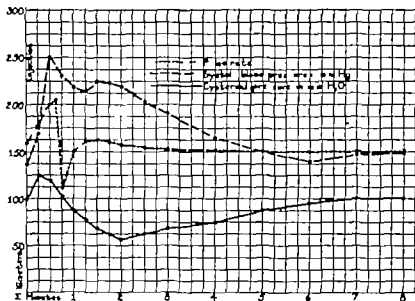


Fig. 6. Reactions of dog to 5 cubic centimeters of epinephrine 1:10,000. Basal paraldehyde narcosis.

The considerations discussed suggested further experiments the first to determine the duration of paralysis of an isolated nerve such as a spinal root filament when exposed to procaine of various concentrations the second to compare the changes in respiration and cerebrospinal fluid pressure produced during spinal anesthesia by drugs which cause a rise or fall of blood pressure and the third to recover distal fluid during the respiratory paralysis following lumbar injection of procaine and to determine its effect when injected into the ventricle of an intact animal.

#### PARALYSIS AND RECOVERY OF AN ISOLATED NERVE

In order to determine the time required for motor functions of an isolated nerve to recover from procaine anesthesia a segment of approximately 2½ centimeters of the sciatic nerve of a frog nerve muscle preparation was exposed to procaine of various concentrations. The nerve was threaded through a small glass chamber and sealed with petrolatum jelly so that it could be entirely covered by the drug without leakage. An inlet and an outlet to the chamber were provided so that irrigation with Ringer's solution could be carried out. An automatic "make and break" stimulus was

applied every minute and muscle contractions recorded on a revolving drum. The nerve muscle preparation was held in a moist chamber.

One per cent procaine plus epinephrine caused paralysis in 7 minutes, and recovery time although rather variable, was usually of about the same duration as the time of exposure to the drug (Fig. 3). Ten per cent procaine plus epinephrine caused paralysis in 4 to 6 minutes on the average and in four trials recovery was much delayed, from 40 to 80 minutes of irrigation being necessary after an exposure of only 10 minutes (Fig. 4). Pitkin's "spinocaine" at two trials caused paralysis in 5 minutes, and after a 10 minute exposure recovery took place with 20 minutes of irrigation (Fig. 5). This is evidence against the claim that "Spinocaine" fluid is fixed within nerve tissues by the substances contained in it.

#### CHANGES IN PRESSURE OF THE CEREBROSPINAL FLUID AND EFFECTS ON RESPIRATION PRODUCED BY DRUGS

*A. Before spinal anesthesia.* The animals for these experiments were prepared with

The concentrations of procaine present in "Spinocaine"

"Spinocaine" is reported to contain:

Procaine, see next.

Epinephrine sulphate, 1 mgm.

Solvent containing starch derivatives and 4% alcohol, cm.

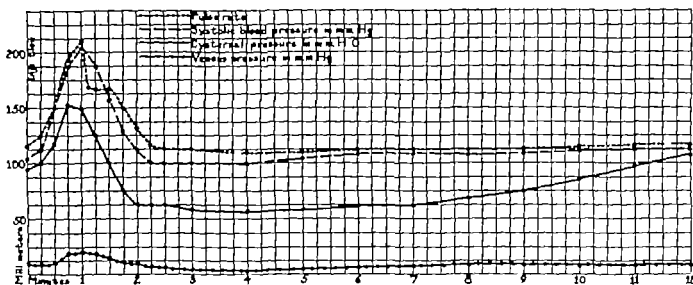


Fig. 7 Reactions of dog to 1 cubic centimeters of epinephrine 1:10,000. Basal barbital narcosis.

OR BLOOD

basal narcosis in the same manner as for injections of procaine. Cisternal pressure was considered to be representative of the cerebrospinal fluid pressure when the animal was horizontal. Readings were taken from a "U tube" which communicated with the cisterna magna as described.

The intravenous injection, in the normal animal, of epinephrine (1 cubic centimeter 1:10,000) or phenyl ether of choline (2 milligrams)<sup>1</sup> resulted in effects which are conveniently described in two phases. At first, during the short rapid rise of blood pressure and pulse rate the cisternal pressure rose 25 to 30 millimeters of water, and there was a short cessation of respiration. The depressor reflex then followed producing a fall of blood pressure to a level below normal with vagal effects showing on the pulse chart. During the depressor reflex the cisternal pressure fell 50 to 60 millimeters of water below normal. This latter phase was accompanied by deep and rapid respiration less evident after phenyl ether of choline (Fig 6). When sodium barbital was used for anesthesia in place of paraldehyde there was a greater and more prolonged rise in cisternal pressure before readjustment (Fig 7).

Inhalation of one ampul of amyl nitrite resulted in a marked fall of blood pressure

a rise in venous pressure a rise in cerebrospinal fluid pressure of 20 to 40 millimeters of water, and extremely deep and rapid respirations (Figs 8 and 9). The intravenous injection of 0.2 milligram of acetyl choline gave similar results except that respirations were hardly affected in any way.

*B During spinal anesthesia.* When 150 milligrams of procaine in 1 cubic centimeter of Ringer's solution was injected into the lumbar region of the cerebrospinal system there was an immediate rise in cisternal pressure which continued as the blood pressure fell and as respiration became paralyzed. This reaction ceased at the end of about 10 minutes, during which time venous pressure had risen slightly (2 millimeters of mercury) above its former level, and the cisternal pressure was 50 to 100 millimeters of water above its former level both remaining at these new base lines.

The intravenous injection of epinephrine in such an animal caused a marked rise of cisternal pressure to 300 or 400 millimeters of water (from 175 millimeters) returning quite promptly to the former level when the epinephrine reaction ceased. Venous pressure nearly doubled during this period. Phenyl ether of choline caused a similar effect. Artificial respiration was continuously administered during this experiment because of the paralysis due to the high level of anesthesia (Fig 10).

<sup>1</sup> This drug produces a marked sympathomimetic action, due chiefly to stimulation of the ganglion cells of the sympathetic system. It has very little depressor effect, and it does not affect respiration as markedly as does epinephrine.

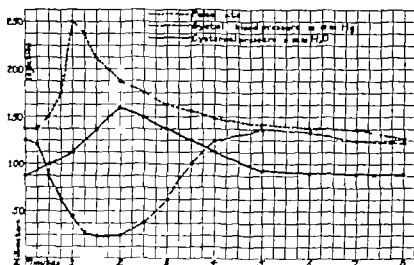


Fig. 8. Reactions of dog to ampel of amyl nitrite. Basal paraldehyde narcosis.

The administration of amyl nitrite or acetylcholine caused a drop in cisternal pressure amounting to 25 to 40 millimeters of water without demonstrable change in arterial or venous pressure. (The arterial pressure was already at the low level of high spinal anesthesia.) (Fig. 10)

Ephedrine (dose 25 milligrams) injected intravenously before the induction of spinal anesthesia resulted in a prolonged elevation of blood pressure and pulse rate such that the induction of spinal anesthesia did not cause a fall of blood pressure or a paralysis of respiration in four trials. At three of these trials 600 milligrams of procaine was injected into the lumbar space in as much as 4 cubic centimeters of Ringer's solution and yet diaphragmatic respiration continued although the thoracic muscles seemed paralyzed as described. The large dose was given and repeated because at first it was thought that some of the drug had leaked out of the subarachnoid space around the needle.

Observations of cisternal pressure were repeated in the animals in which diaphragmatic respiration remained intact after the injection of ephedrine and after the induction of spinal anesthesia. In these instances both amyl nitrite and acetylcholine caused a marked transient fall in blood pressure a drop in cisternal pressure of 24 to 40 millimeters of water and a transient but definite cessation of respiration producing cyanosis. A very short period of artificial respiration was considered necessary after these drugs, because of the critical condition of the animal but function returned within 10 to 20 minutes. The marked reactions which were produced in these instances were due to vasodilatation which undoubtedly resulted in venous engorgement cardiac dilatation and deficient circulation of the bulbar centers.

Other observations deserving of mention are as follows. One experiment was undertaken to determine the effect during spinal anesthesia of withdrawal of spinal fluid produced by hypertonic solutions in an animal with intact respiration. Under such circumstances would the drug be drawn upward into the region of the phrenic filaments or the vital centers? Fifty cubic centimeters of 20 per cent sodium chloride were injected slowly into a vein in order to produce a resorption of cerebrospinal fluid. The injection was soon followed by a rise in cisternal pressure of 50 millimeters of water and during this elevation of pressure the respirations gradually failed ceasing 5 minutes after the injection had started. The blood pressure slowly fell to a low level and within 30 minutes the cisternal pressure had descended from 300

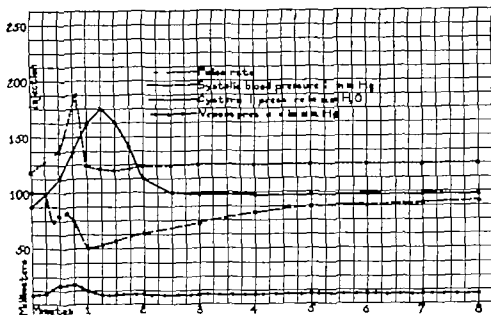


Fig. 9. Reactions of dog to 1 ampul of amyl nitrite. Basal barbital narcosis.

millimeters of water to zero. With cisternal pressure at this low level epinephrine, phenyl ether of choline, acetyl choline and amyl nitrite caused small but definite changes of cisternal pressure similar in effect to those observed before the spinal fluid pressure had been so greatly changed. After 40 minutes of respiratory paralysis without any sign of a rise in the cisternal or blood pressure, or of the return of respiration recovery was produced by small intravenous injections of a total of one hundred cubic centimeters of distilled water, with the result of a gradual rise of cisternal pressure to 150 millimeters of water and a gradual return of normal blood pressure and respiration.

Effects of asphyxia and hæmorrhage were studied in order to assist interpretation of other findings. Asphyxia was produced by occlusion of the tracheotomy tube. If the animal had an intact respiratory mechanism, the thorax and diaphragm made powerful efforts to bring air into the lungs thus causing an increase in depth of oscillations of the cisternal pressure until they varied as much as 90 millimeters of water between inspiration and expiration and the mean level of cisternal pressure doubled in height. The entire system returned to normal within a minute after air was allowed to enter the lungs without obstruction. However, if asphyxia

was continued for over 6 minutes the cisternal pressure fell as the circulation failed. During paralysis of respiration after induction of high spinal anesthesia asphyxia produced a gradual fall of cisternal pressure until the death of the animal occurred. On the other hand the cisternal pressure rose during the early part of asphyxia when a high blood pressure level had been maintained by preliminary administration of ephedrine before paralysis of respiration. In the course of a long experiment with spinal anesthesia during which the blood pressure remained low because of general vasodilatation the cisternal pressure slowly rose. Hæmorrhage caused a gradual fall of cisternal pressure. Stimulation of the peripheral end of one of the vagi resulted in a transient fall of blood pressure and a coincidental fall of cisternal pressure of 20 to 30 millimeters of water.

#### VENTRICULAR TEST OF CISTERNAL FLUID

One cubic centimeter of fluid was withdrawn from the cisterna magna of an animal whose respirations had been paralyzed by spinal anesthesia (150 milligrams of procaine injected into the lumbar region) and this cubic centimeter of fluid was injected into the lateral ventricle of another dog. No changes characteristic of procaine action

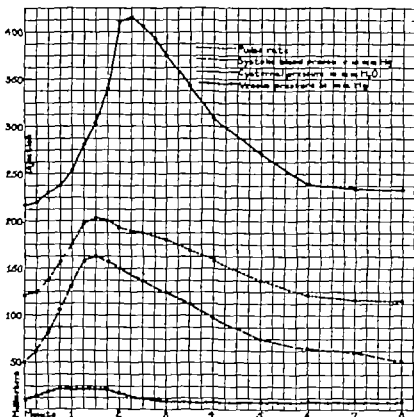


Fig. 10. During spinal anesthesia. Reactions of dog to 2 cubic centimeters of ephedrine 1:10,000. Basal barbitol narcosis.

were observed in any of the six experiments performed. There was no noticeable effect on blood pressure, pulse rate or respiration.

In one of these instances, after the distal fluid was removed, the animal was given an intravenous injection of 100 cubic centimeters of 15 per cent sodium chloride to produce a reduction of volume of cerebrospinal fluid. After 20 minutes a second cubic centimeter of distal fluid was removed for ventricular test, which produced a transient fall in blood pressure and respirations became more shallow but the reaction was over in 3 to 4 minutes.

The ventricular test also was performed on four specimens of spinal fluid obtained in the surgical clinic. The first was normal fluid removed from a patient prior to the induction of spinal anesthesia. To this control specimen (1.5 cubic centimeter volume) was added

15 milligrams of procaine. The 3 other specimens were obtained from patients at the termination of operations performed under "spino-calne" anesthesia 1 to 1½ hours after induction. One patient had received 200 milligrams, another 300 milligrams and another 400 milligrams of spino-calne. At the time these specimens were removed from the patients it was demonstrated that the anesthesia was complete and it had not extended above the level of the umbilicus. The specimens all stood overnight, as did the control, which was used to determine whether the procaine was inactivated by the cerebrospinal fluid. Only one specimen the control, produced a paralysis of respiration when tested in the dog's ventricle. In this instance blood pressure fell the pulse slowed and respirations were paralyzed for 5 minutes. The animal completely recovered in 10 minutes. One of the other specimens produced a very slight

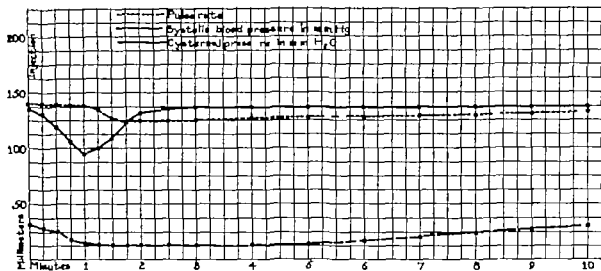


Fig. 11 During spinal anesthesia. Reactions of dog to 1 ampul of amyl nitrite. Basal paraldehyde narcosis.

drop in blood pressure and a very slight change in the quality of the respirations but this effect might have been produced by any foreign material introduced into the ventricular system, or it may have been due to a very slight procaine effect. These facts indicate that in these instances the procaine had been diluted or resorbed so that its concentration in 1 cubic centimeter was less than that required to produce an effect upon the vital centers of a dog. Achard has demonstrated that when injected subdurally the resorption of procaine begins very soon, reaches a maximum in 2 hours and is complete after 6 hours.

#### DEDUCTIONS FROM STUDY

The ventricular injection of procaine undoubtedly caused a paralysis of the respiratory center, producing an immediate cessation of respiration which later recovered as a co-ordinated function. The result was so prompt after injection that the site of action of the drug must be very near the surface of the ventricle, and quite near the site of injection. Blood pressure and pulse effects also were rapid in their appearance and these phenomena recovered fairly rapidly and completely indicating that centers for the maintenance of vascular tone and cardiac acceleration were involved in the paralysis.

The injection of procaine into the cisterna magna produced a reaction which appeared

objectively to have been due to a downward diffusion of the drug since the order of events (with the exception of intercostal paralysis) was the opposite of that produced by the lumbar injection, yet a central paralysis similar to that produced by Cotui and Standard may have occurred. On the other hand, recovery from the injection was slow and incomplete clearly indicating that the drug also acted otherwise than on centers, possibly the spinal nerve filaments.

The reaction after lumbar injection was similar to that described by Ferguson and North. The effect was undoubtedly produced by upward diffusion of the drug because objectively the sequence of paralysis followed anatomical structures susceptible to narcosis. The slow recovery of these animals resembled that observed after cisternal injections. The known resistance of the phrenic nerve filaments to narcosis however, made it necessary to be skeptical in attributing the paralysis of respiration to phrenic effects in the case of lumbar injections because dilution of the drug undoubtedly occurred as upward diffusion proceeded a thing not so likely to be the case with cisternal injections placed so much nearer the phrenic filaments.

The remarkable fact that no paralysis of respiration occurred after the lumbar injection when vascular tone was maintained by preliminary administration of ephedrine, led to the conclusion that the function of the



respiratory center fails if circulation falls below a certain level of efficiency. The administration of amyl nitrite and acetyl choline to animals with intact respiration after epinephrine and during spinal anesthesia demonstrated the close relation of failure of respiration to a fall in blood pressure because both these drugs caused inadequate respiration for 10 to 20 minutes during which time the animal was in a precarious condition requiring artificial respiration.

The studies of cisternal pressure undertaken in order to correlate the cerebrospinal fluid dynamics with the above finding demonstrated that in the normal animal the cerebrospinal fluid pressure is actually protected from marked fluctuations by the vasomotor system. The following observations deserve discussion.

1 *Before spinal anesthesia.* Blood pressure raising drugs produced a rise in cisternal pressure during the pressor phase, with a fall during the depressor phase readjusting as the action wore off.

Blood pressure depressing drugs before spinal anesthesia produced a sudden rise in cisternal pressure paralleling a marked rise of pulse rate and venous pressure. No compensatory fall occurred.

2 *In the presence of spinal anesthesia.* The responses were far more marked especially the rise after epinephrine in which cisternal pressure soared to 400 millimeters of water and the fact that compensatory pressor or depressor reactions failed to appear was notable.

After the injection of epinephrine no depressor reflex occurred and likewise after administration of amyl nitrite or acetyl choline, no pressor reflex took place. The cisternal pressure changes produced by these drugs in the presence of spinal anesthesia were exactly those to be expected in the absence of a vasomotor system representing a total inability of the animal to compensate for rapid changes of circulation. These observations give conclusive proof to the presumption that paralysis of the sympathetics takes place coincidentally with the loss of vascular tone and the fall of blood pressure in spinal anesthesia.

The demonstration that cisternal fluid from an animal with respiratory paralysis produced by spinal anesthesia does not cause any noticeable effect on blood pressure or respiration when injected into the ventricle of another susceptible animal would prove that *procaïne* is not present in the *cisterna magna* in amounts sufficient to act upon the vital centers and that the important action on both respiration and blood pressure is by some other mechanism. This fact is of great importance provided it can be correlated with the knowledge that anesthesia of the face without paralysis of respiration may be produced by surgical spinal anesthesia. In order to have caused anesthesia of the face the drug must have entered the *cisterna basalis* without having produced narcosis of all the phrenic filaments.

The experimental evidence presented does not indicate whether or not phrenic filaments are paralyzed as they pass through the subarachnoid spaces, although the experimental and clinical evidence both indicate that the collapse of respiration is closely related to respiratory failure. It seems inevitable to conclude that in the experiments with lumbar injections a deficiency of circulation is so intimately associated with failure of respiration that adequate support of the circulatory mechanism may be expected to prevent respiratory failure.<sup>1</sup>

Other matters of interest not directly concerned with spinal anesthesia deserve discussion. The immediate failure and rapid recovery of respiration after ventricular injections show that this center lies relatively near the surface of the ventricular system and quite near the site of injection. The curious phenomena observed during the recovery of respiration in which the animal passed through three different phases of respiration, support the investigations of Lumsden who has demonstrated the complexity of the respiratory center and has defined gasping, apneustic and pneumotaxic centers of respiration.

The immediate effect of ventricular injections of procaine in producing a fall of blood

Dr. Stanley Newark has recently presented evidence to the effect that procaine is so rapidly absorbed from the cerebrospinal system into the blood stream that in some instances symptoms of circulatory collapse and respiratory failure may result as soon as intravenous injection.

pressure and a slowing of the pulse rate both of which took place simultaneously indicates the close relation of these two functions. It may be true that the cardio-accelerator center and the vasomotor center are identical. That epinephrine, when injected into the ventricle does not act upon the vasomotor center was demonstrated. On the other hand ephedrine produced the immediate effect of a moderate rise of blood pressure and pulse rate and after 10 to 15 minutes a more marked and prolonged rise took place presumably because of a peripheral action. In these animals neither epinephrine or ephedrine affected respiration, in contrast to the intravenous injection of epinephrine which produces a short period of apnea, possibly because of constriction of the arterioles immediately adjacent to the center. It seems probable therefore, that although the respiratory and vasomotor centers lie relatively near the surface of the ventricular path they are actually beneath the surface where their arterioles are not subject to the vasoconstrictor action of epinephrine if it is injected into the cerebrospinal system.

#### CONCLUSIONS

There is no evidence to indicate that during spinal anesthesia procaine diffuses in the cerebrospinal system as far as the centers of respiration to produce respiratory paralysis by direct action. In experimental animals during respiratory paralysis following spinal anesthesia there is not sufficient procaine in the fluid of the cisterna magna to produce an effect on the centers of respiration and vasomotor control. The collapse of circulation and resultant bulbar anemia appear to be intimately associated with respiratory failure. The deficiency of circulation is the result of an extensive action of the drug on nerve elements of the filaments of the spinal cord producing paralysis of the sympathetic system (Smith and Porter) and the cardio-accelerator mechanism and paralysis of costal respiration (Ferguson and North). The results of these effects are a loss of vascular tone and changes in circulatory mechanisms for which compensation cannot be made by the central nervous system.

The following observations support this statement.

1 A comparison of the changes of cerebrospinal fluid pressure produced before and after induction of spinal anesthesia by drugs which cause a rise or fall of blood pressure demonstrated in the animals studied that the function of the entire sympathetic system was abolished by the spinal anesthesia.

2 Paralysis of the vital centers of respiration and vasomotor control produced by procaine injected into the ventricles of dogs is of short duration and recovery is complete provided artificial respiration is adequately maintained throughout the period of paralysis. Were the respiratory failure produced solely by paralysis of the centers recovery would take place far more quickly and in a different manner than is actually the case.

3 Cisternal fluid obtained at the time of respiratory failure following spinal anesthesia did not contain enough procaine to produce an effect on the centers of an intact animal when injected into the ventricles.

4 Paralysis of respiration during spinal anesthesia did not occur when a fall of blood pressure did not take place or was prevented by preliminary administration of ephedrine.

5 Failure of respiration was produced during recovery from spinal anesthesia by change in posture to the horizontal from Trendelenburg position, and similar effects were precipitated by amyl nitrite or acetyl choline which was administered to animals the circulatory and respiratory mechanisms of which were maintained by ephedrine during spinal anesthesia.

6 Recovery of respiration was preceded in all instances by improvement in circulation.

#### REFERENCES

1. ACHARD H. P. *Progrès méd.* 1910, xxiv 70.
2. BOWER, JOHN O. CLARK J. H. WAGOWER GEORGE and BURNS, J. C. Spinal anesthesia, a summary of clinical and experimental investigations with practical deductions. *Surg. Gynec. & Obst.* 1932 liv 885-897.
3. BOWER JOHN O. CLARK J. H. and WAGOWER GEORGE. *Anesth. & Anal.* 1926 v 95-105.

4. COTUI, FRANK WARD, and STANDARD SAMUEL. Experimental studies on subarachnoid anesthesia. I. Paralysis of vital medullary centers. *Surg. Gynec. & Obst.* 1932, lv 290-297.
5. EVANS, C. H. *Am. J. Surg.*, 1912, v 581-593.
6. FERGUSON, L. KRAEHL, and NORMAN, JOHN PAUL. Observations on experimental spinal anesthesia. *Surg., Gynec. & Obst.* 1932 liv 62-634.
7. GASSER, H. S., and ELLAHOFF, J. *Am. J. Physiol.* 929, lxxviii, 531-591.
8. HATCHER, R. A., and LOGGISTON, C. *J. Pharmacol. & Exper. Therap.* 916 viii, 385.
9. HUNT, REID. Personal communication with the author.
10. HUNT, R., and RUDENOW, R. R. *J. Pharmacol. & Exper. Therap.*, 1929, xxxv 99-123.
11. LUMBURY, T. *J. Physiol.*, 1923, lvii, 153-160. *Ibid.* 1923 lviii, 111-126.
12. NOWAK, S. J. G. Personal communication with the author.
13. SCHULZ, L. and ZIEGLER, H. *Arch. f. klin. Chir.*, 1924, cxxx, 352-359.
14. SMITH, G. G. and PORTER, W. T. *Am. J. Physiol.*, 1913, xxxvii, 103-127.

## CARCINOMA OF THE BLADDER

BENJAMIN S. BARRINGER, M.D. F.A.C.S., New York  
Memorial Hospital

THIS paper is based upon the records of 78 controlled cases of bladder carcinoma which have been taken mainly from the cases seen and treated by radium in the Memorial Hospital<sup>1</sup> during the past 18 years. The individual histories of these cases are briefly published. This record includes the operation, the amount and method of use of radium, the cystoscopic examination, the pathology and the report of the Bladder Carcinoma Registry whenever the case has been registered, together with the length of time of control.

This method of publishing individual case histories is used because in this way one may study much more accurately the dosage of radium used, the kind and extent of tumor controlled with the pathology of controlled cases. Controversial points and there are many concerning bladder cancer, cannot in the least be settled by publishing statistics. These latter can give only a vague clue as to the approach and methods of any one surgeon in any given class of cases.

*Pathology of the controlled cases.* Of our 78 controlled cases<sup>2</sup>, 48 of them have been graded according to the scheme of Broders. Nine cases were Grade I, 24 cases were Grade II, 14 cases were Grade III, and 1 case was Grade IV. Some of these have been graded by Ewing, some by the Carcinoma Registry, and some by both.

Ewing's Grade I corresponds as a rule to Broders' Grade II. Broders' gradations are followed by the Carcinoma Registry. Ewing's papilloma is not graded as a bladder cancer, while as a rule Grade I according to the Carcinoma Registry means a papilloma.

There are tumors which stand between "pure papilloma" and "papillary carcinoma." Geraghty called these malignant papilloma. They have malignant features which pure papilloma has not. The 9 cases of Grade I ma-

lignancy are probably of this type. They were so according to the cystoscopic examination, generally being firmer tumors than the papilloma and often partially sloughy tumors. In one of them graded I by the Carcinoma Registry, Ewing made a diagnosis of "solid carcinoma."

So the comparatively few tumors in Grade I were probably cancerous. Of the rest of the 48 graded tumors, there was no question as to their malignancy. The 30 tumors not graded were diagnosed "papillary carcinoma" or "infiltrating carcinoma." No papillomas were included.

*Pathological gradation as to radiosensitivity.* In 55 cases in which the pathologist made an attempt to determine whether the tumor was radiosensitive (these are only partly taken from this series of controlled cases) 27 were thought to be radioresistant and 28 radiosensitive. From Table I there is apparently no relation between the grade of tumor and its radiosensitivity. It is natural to think that the Grade III or Grade IV would be more radiosensitive than a Grade I or Grade II tumor. This is not necessarily true.

*The value of grading tumors according to their malignancy and radiosensitivity.* As far as the treatment by radium implantation of bladder tumors is concerned, I do not believe that the gradation of tumors helps us much (Table II). A highly malignant Grade IV tumor probably should be given external irradiation before any operative interference is undertaken. If the control of the tumor is by operative removal rather than by radium seed implantation, certainly the pre-operative irradiation should be considered. Practically, however, it does not seem to work out well. External irradiation causes increased distress to the already distressed patient, increases frequency of urination, and complicates the healing after operation. The fact that so many bladder tumors, when examined microscopically, present features suggesting that

<sup>1</sup> All except 5 cases are by the Memorial Hospital records, 4 cases were at the 315th Avenue Hospital and 1 case at the Lenox Hill Hospital.  
<sup>2</sup> I have omitted from this series a number of controlled cases in which there was no adequate or a misleading pathological examination.

TABLE I.—RADIOSENSITIVITY OF BLADDER TUMORS

	Radio-resistant	Radio-sensitive
Grade I		
Grade II	17	13
Grade III	8	0
Grade IV	1	3

they may be radiosensitive might indicate that some could be controlled by external irradiation alone.

At the Memorial Hospital we have not been able to get very far along this road. The reason for this is possibly that the results of radium implantation directly into a tumor have been so good that we were loathe to try an experiment. We do know however that external irradiation alone is singularly impotent in controlling the bleeding of a bladder tumor and if the bleeding cannot be controlled we have believed that the tumor certainly can not be controlled. I believe that most bladder tumors are notwithstanding the pathological readings not radiosensitive. That is they are not markedly influenced by external irradiation. In looking over the pathological examinations, I have found in 3 different cases the following confusing results. In 2 cases the tumor was graded as Grade III markedly radiosensitive at another time Grade II radioresistant. Another case was graded as Grade III (by the Memorial Hospital) radioresistant and by the Carcinoma Registry Grade III radiosensitive. A patient with a highly malignant radiosensitive tumor should be most carefully examined before operation for metastases. These tumors frequently metastasize very early.

*Control of various grades of malignancy.* In analyzing our cases it would seem that we have controlled by interstitial irradiation one class of cases as well as another and the number of controlled cases in each grade of malignancy corresponds pretty well with the percentage frequency of the different grades of malignancy. That is, we have controlled more cases in Grade II and that is by all means the most frequent grade of bladder carcinoma. We have controlled but 1 case in Grade IV but Grade IV is relatively rare.

*The changes of the grade of malignancy of the same tumor in the same patient.* The fol-

TABLE II.—GRADE OF MALIGNANCY—48 CASES GRADED OUT OF 78 CONTROLLED CASES

	Cases
Grade I	9
Grade II	24
Grade III	14
Grade IV	1

lowing patient was first seen in September 1931 the diagnosis was epithelial papilloma with atypical cells (specimen obtained with cystoscope). On October 17 1931 specimen diagnosed as cystotomy as papillary epidermoid carcinoma Grade I. On April 8 1932 specimen by cystoscopy diagnosed as papillary epidermoid carcinoma Grade II. At the second cystotomy December 10 1932 the specimen showed epidermoid carcinoma Grade III relatively radiosensitive. Of course we who do radium implantation are at a disadvantage because we get only a portion of the tumor. These changes in the apparent degree of malignancy of a tumor may have been influenced by the treatment.

Another case was diagnosed on March 7 1928 as cystitis, no tumor, on March 21 1928 as simple papilloma on April 17 1928, as infiltrating carcinoma Grade II, radioresistant on March 7 1929 as epidermoid carcinoma Grade II radioresistant on November 26 1929 as epidermoid carcinoma Grade III relatively radiosensitive (Table III).

*Operative mortality.* I have always insisted that the suprapubic operation and radium implantation is a relatively benign operation. In my first 109 consecutive personal cases 4 patients died in the hospital, an operative mortality of 3.6 per cent. In 179 consecutive cases (Table IV) my operative mortality has gone up 13 patients dying in the hospital giving an operative mortality of 7.3 per cent. When one considers that the large majority of these cases, however were, from the surgeon's standpoint, inoperable (if one excludes total cystectomy) one realizes that this is a low mortality rate. In 7 cases I did a second cystotomy and radium implantation while in another case I opened the bladder three times in a vain attempt to control the growth. In 1 of these 8 cases there was an operative death in the hospital. This certainly emphasizes the relative benignancy of the operation.

TABLE III—DIFFERENT GRADES OF MALIGNANCY IN THE SAME PATIENT

September 28, 1931	Specimen through cystoscope epithelial papilloma, atypical cells.
October 17, 1931	Specimen at cystotomy papillary epithelioid carcinoma, Grade I
April 8, 1932	Specimen at cystoscopy papillary epithelioid carcinoma, Grade II
December 10, 1932	Specimen at cystoscopy epithelioid carcinoma, Grade III relatively radiosensitive.
January 3, 1933	Cystotomy specimen epithelioid carcinoma Grade II plus, radioresistant.

TABLE IV—MORTALITY OF CYSTOTOMY OPERATION AND RADIUM IMPLANTATION

Number of cystotomy operations	19
Number of deaths in hospital	13
Mortality per cent	78

TABLE V—AGE CHART—78 CONTROLLED CASES

Age	Cases
30-40	1
40-50	13
50-60	33
60-70	25
70-80	4
Not given	2

*Age of controlled cases* The great majority of patients were in the decades between 50 and 60 and 60 and 70 (50 to 60—33 cases and 60 to 70—25 cases), 1 patient was between 30 and 40 and 4 patients were between 70 and 80 (Table V).

*Time well in years* Patients are not considered well unless they have either gone a sufficient length of time without symptoms a year or more, or their bladder is proved to be tumor free by cystoscopic examination or as seen through a cystotomy wound this operation being done for some complicating process. It is interesting to note in Table VI that 31 patients are well between 5 and 10 years, 10 between 10 and 15 years, and 1 between 15 and 20 years. This last one is an old woman who has reached her ninetieth birthday.

*Size of tumor base in 78 controlled cases* The size of the tumor itself has no relation to the curability of the tumor (Table VII). The size and the position of the base has a direct relation as to whether it can be controlled. A tumor may fill the bladder yet may be pedunculated and attached to the bladder wall by a very small base. Such tumors are of course very favorable for implantation. It is inter-

TABLE VI—TIME WELL IN YEARS—78 CASES

	Cases
0-1	6
1-2	8
2-3	4
3-4	12
4-5	6
5-10	31
10-15	10
15-20	1

TABLE VII—SIZE OF THE TUMOR BASE—78 CONTROLLED CASES

	Cases
1 square centimeter	2
2-4 square centimeters	19
4-6 square centimeters	16
6-10 square centimeters	9
10-30 square centimeters	12
30-50 square centimeters	6
50+ square centimeters	7
Extensive	4
Not given	4

TABLE VIII—SITE OF TUMOR—78 CONTROLLED CASES

	Cases
Base touching trigone or ureters, or internal urethra	48
Lateral walls	15
Base back of trigone	8
Vault	2
Not given	5

esting to note that of 74 tumors of which the size of the base was given, all but 37 had a base larger than 6 square centimeters. 4 were recorded as extensive, and 7 had a base of more than 30 square centimeters. This gives an index as to the relative inoperability of many of these tumors.

*The site of the tumor in 78 controlled cases* I have classified the site in four divisions (Table VIII). One a tumor of the base of the bladder touching the trigone or ureters or internal urethral orifice. There were 48 such tumors a large majority, 15 were of the lateral walls. 8 on the base back of the trigone, and but 2 of the bladder vault. In 5 the site was not given. The fact that in a large majority of cases the tumors are situated on or adjacent to the trigone is what makes operation in these cases so signally difficult and puts many of them in the inoperable class unless one considers that most malignant of operations for a malignant tumor total cystectomy with ureteral implantation. Tumors of the bladder vault while much more accessible are much more malig-

TABLE IX.—CASES OPERABLE OR INOPERABLE IF SURGICAL REMOVAL WERE CONSIDERED

	Cases
Operable	33
Inoperable	43
Borderline	2

nant and more prone to metastasize than tumors elsewhere situated.

*Operable versus inoperable* I have attempted in a very rough way to put myself in the position of the surgeon who might attempt to remove a bladder tumor by operation. This naturally varies with the skill and experience of the surgeon. I have considered a case inoperable if it is at all extensive and directly involves one or both ureteral orifices, the internal urethra or a part of the trigone. I do not believe any surgeon can show many such cases in which the operation has resulted in the cure of the patient.

With this classification in view I have considered that 43 cases were inoperable 33 operable and 2 were borderline cases (Table IX).

*Complications of cystotomy and radon implantation* The first and of course most important complications are the deaths occurring in the hospital (Table XI). Of the 13 deaths, 2 had proved metastases to the lungs and the liver 1 died uræmic—he had a high non-protein nitrogen content before operation but we believed that there was a chance that we could control his tumor 1 died of a diabetic coma—he had a fairly high blood sugar before operation 2 died of exacerbation of an old kidney infection in both of these there had been a previous cystotomy and treatment of the bladder tumor 1 died as far as we could determine of infection of the kidneys 6 died of heart failure which was probably dependent upon and secondary to an infection of the bladder and kidneys. It is possible that some of these patients should not have been operated upon. On the other hand as there was a possibility of cure I believe the operation was justified.

The complications which occurred in the 78 patients, in whom the tumor was controlled, were the following 9 had bladder stones, in 3 of which suprapubic removal had to be done 1 had a stricture of the urethra 4 had somewhat severe infections of the bladder and kid-

TABLE X.—PROOF OF CURE—CONTROLLED CASES

	Cases
Bladder normal by cystoscopy or through cystostomy wound	6
Patient normal as to symptoms not proved cystoscopically	7

neys 2 had urethrectal fistulas and 3 had a suprapubic fistula which persisted for a long time 2 had vesicovaginal fistulas 3 had carcinomatous implants in the suprapubic wound 1 had such a severe infection of one kidney that a nephrostomy had to be done to drain it and 1 had to have a bilateral nephrostomy because of an inflammatory stricture of the lower portion of the ureter both of these patients eventually died. Taken all in all, when one considers the inoperability of many of the cases in which radium was implanted these complications are surprisingly few. The worst single complication that one has to deal with is infection of the bladder and kidneys which may follow radium implantation of a tumor. Many of these advanced tumors are badly infected and the placing of radon seeds in them does not help that infection. How to deal properly with this problem is a matter for the future. Perhaps long preparation of such patients with an attempt to sterilize the tumor by some antiseptic may be the answer.

Three patients in whom the tumor was controlled died from prolonged infection caused by the treatment—1 in 9, 1 in 8 1 in 3 years.

The average time spent in the hospital by 22 patients taken at random on whom suprapubic implantation was done was 22 days.

*Varieties of irradiation.* The different forms of irradiation as applied to bladder tumors have been discussed at length in various papers. I think at the present time we have pretty well proved that the use of radon seeds of low value between 1 and 1½ millicuries placed a little nearer than 1 centimeter apart is the ideal type. Contrary to what is generally believed such implantations even if they be near the internal urethra do not cause an undue amount of pain. Infection is the variable element. If there is infection plus irradiation the patient may have pain for a considerable time (some weeks). We at times have been accused of having given too heavy doses of radium in bladder tumors undoubtedly this is true. One must remember much of our

TABLE XI.—COMPLICATIONS IN 78 CONTROLLED

CASES	Cases
Stone bladder	0
Stricture urethra	1
Infection bladder and kidneys	2
Infection kidney	2
Urethrovaginal fistula	0
Urethrorrectal fistula	2
Suprapubic fistula	3

work has been experimental. A perusal of the 78 controlled cases, however, seems to justify whatever method of irradiation we have used. I do not believe that there is any other extant method by which such a large number of inoperable cases could be controlled (Table XII).

**Advantages and disadvantages of irradiation.** These have been largely covered in various portions of my paper. Certainly the advantages are that a good many small tumors can be controlled without mortality without operation, by cystoscopic implantation. In tumors of the base of the bladder which constitute the large majority radium certainly has a vast advantage over operative removal.

**The future.** The future lies in the earlier diagnosis by cystoscope the more accurate diagnosis by pathological examination and the realization that even the smallest bladder tumor, if it be cancerous is a grave disease not to be treated by inadequate means.

For the larger tumors we can set no rule. If we believe that such tumors are confined to the bladder we should have no mental restriction that a tumor of a certain size is hopeless. We should vigorously attempt to control these large tumors. Each year ought to see us more adequately equipped to do this.

The histories of the 78 controlled cases are not given in full. Only sufficient material is included to enable one to get an accurate idea

of the kind, extent, and position of the bladder tumor, together with the method of irradiation and amount of radium used for control. No mention is made of complications. The time of control is reckoned from the patient's first treatment to time last seen or heard from.

As a rule the grading of tumors by the Carcinoma Registry is one number higher than the grading of the Memorial Hospital. For example Carcinoma Registry Grade II corresponds to Ewing's Grade I. This is by no means always so.

C. A. G. Memorial Hospital, admitted November 1, 1915, female, aged 60 years. Cystoscopy showed a sloughy sessile bladder tumor 3 by 3 centimeters on left ureter on January 19, 1916 1 bladder tube of radon screened by  $\frac{3}{8}$  millimeter silver was inserted through cystoscope 800 millicurie hours and applied to tumor. Pathological examination Alveolar carcinoma. Cystoscopy 4½ years later showed a normal bladder. In October 1926 patient sitting at the supper table, died of heart disease.

J. A. H. Memorial Hospital admitted July 31, 1916 male aged 62 years. Cystoscopy showed a sloughy sessile bladder tumor 1 by 2 centimeters on left ureter. In October 1916 2 bladder tubes of radon—1134 millicurie hours—were applied to tumor on February 20, 1917 2 bladder tubes of radon—600 millicurie hours—applied to tumor. Pathological examination carcinoma. In 1921 the patient had a normal bladder on cystoscopy. Died in 1921 from cerebral hemorrhage.

P. M. Memorial Hospital admitted October 2, 1916 female aged 72 years. Cystoscopy showed papillary bladder tumor 2 by 3 centimeters on trigone and base on December 2, 1916 2 bladder tubes of radon—1400 millicurie hours—applied to tumor. In March, 1919 bladder tube of radon unscreened—733 millicurie hours—applied to recurrence. Pathological examination papilloma infiltrating base. In March 1933 the patient is well.

A. J. VanW. Memorial Hospital admitted May 16, 1917 female, aged 59 years. Cystoscopy showed bladder tumor 2½ by 2½ centimeters in left urethral orifice. On May 22, 1917 2 bladder tubes of radon 50 millicuries 6½ hours—650 millicurie hours—applied to tumor. On November 20, 1917 2 bladder tubes of radon 49 millicuries and 91 millicuries for 8 hours—1120 millicurie hours—applied to tumor. Pathological examination papilloma with malignant tendencies. On June 23, 1918, cystoscopy showed almost no tumor. Patient died in December 1926 from cancer?

M. E. R. Memorial Hospital, admitted May 27, 1917 female, aged 63 years. Cystoscopy showed papillary bladder tumor 2¼ by 1¼ centimeters back

TABLE VII.—METHOD OF RADON IMPLANTATION—78 CONTROLLED CASES

	Cases
Cystotomy operation	54
Cystoscopic application	26
In 2 cases both cystotomy operation and cystoscopic application were responsible for cure.	

TABLE VIII.—THREE AND FIVE YEAR CURES—205 PERSONAL CASES

	Cases	Per cent
Well 3 years	56	27
Well 5 years	39	19

<sup>1</sup>This seems an incorrect report because of the time, 9 years. There was no autopsy. Probably she died of some bladder and kidney infection.



of right ureter 2 bladder tubes of radon 45 millicuries for 7 hours—630 millicurie hours—applied to tumor. Pathological examination papilloma with atypical cells. In October 1923 cystoscopy showed no tumor.

H. F. R. Memorial Hospital, admitted June 25, 1917, male, aged 68 years. Cystoscopy showed papillary bladder tumor extensive, on right bladder neck 2 bladder tubes of radon 50 millicuries each—800 millicurie hours—applied to tumor on July 3, 1917. Pathological examination papillary carcinoma. In 1919 two stones taken from bladder. In 1926 the patient died of old age.

M. G. Memorial Hospital, admitted October 8, 1918, female, aged 64 years. Cystoscopy showed a pedunculated, firm bladder tumor 2 by 2 centimeters back of right ureter 361 millicuries for 1/2 hour—120 millicurie hours—held against the tumor through cystoscope. This was twice repeated. Pathological examination epidermoid carcinoma. In May 1919, the patient was tumor free cystoscopically. In May 1922, the patient died of cerebral apoplexy.

A. H. C. Memorial Hospital, admitted November 11, 1918, male, 63 years. Cystoscopy showed a slightly bloody bladder tumor on bladder neck more on right side 1 bladder tube of radon 111 millicuries for 5 hours—555 millicurie hours—applied to tumor through cystoscope. Pathological examination cells form malignant epithelial tumor of glandular origin. In May 1920 operation cystotomy for bleeding, no tumor granular cystitis. In September 1921 patient was in a hospital for the insane.

F. M. Memorial Hospital, admitted December 10, 1918, male, aged 48 years. Previous cystotomy at Brooklyn Hospital. Cystoscopy showed bloody multiple tumors 3 by 3 centimeters on bladder neck 2 bladder tubes of radon 50 millicuries for 8 hours—800 millicurie hours—applied to tumor on December 10, 1918. On April 1, 1919, 2 bladder tubes of radon 275 millicuries for 2 hours—551 millicurie hours—applied to tumor. On September 11, 1919, a cystotomy was done and 3 bare tubes of radon 12 millicuries—1584 millicurie hours—implanted in tumors. Pathological examination epidermoid carcinoma. The patient reported entirely well up to the time of his death. He died of uremia following large neglected carbuncle of the buttock on February 24, 1928 at the Brooklyn Hospital.

L. W., Memorial Hospital, admitted July 30, 1919, female, aged 54 years. Cystoscopy showed a bloody sessile bladder tumor 2 by 2 centimeters on left wall near ureter 2 bladder tubes of radon 57 and 58 millicuries for 7 hours—750 millicurie hours—applied to tumor through cystoscope. Pathological examination epidermoid carcinoma. In 1920 the patient had no tumor on cystoscopy. Lost track of patient.

F. H. W. Memorial Hospital, admitted May 3, 1920, male, aged 55 years. Operation cystotomy solid papillary bladder tumor 3 1/2 by 3 1/2 centimeters on left ureter; 7 bare tubes of radon 3.75 millicuries each—627 millicurie hours—imbedded in tumor.

Pathological examination: solid papilloma. Carcinoma Registry papillary carcinoma Grade I. In 1924 the bladder was clean on cystoscopy and in 1926 the patient was well.

H. J. D., Memorial Hospital, admitted May 13, 1920, male, aged 33 years. Operation cystotomy a flat ulcerating bladder tumor 2 1/4 centimeters by 2 1/4 centimeters on right lateral wall, 15 bare tubes of radon 3 millicurie each—584 millicurie hours—implanted in tumor. On October 21, 1920, 1 bladder tube of radon 189 1/2 hours—129 millicurie hours—applied through cystoscope to recurrence. On January 10, 1921, 1 bladder tube of radon 194 hours—130 millicurie hours—applied through cystoscope to recurrence. Pathological examination solid carcinoma. Carcinoma Registry squamous cell epidermoid and adenocarcinoma Grade III (Broders himself diagnosed this). In 1932 the patient is well by several cystoscopies.

A. K. S. Memorial Hospital, No. 27859, admitted on July 7, 1920, female, aged 56 years. Operation cystotomy other bladder tumor 3 by 2 centimeters on left side of base 15 bare tubes of radon 53 millicurie—1049 millicurie hours—implanted in tumor. Pathological examination solid papilloma with infiltrating tendencies. Carcinoma Registry papillary squamous cell carcinoma, Grade III. On April 6, 1933 the patient is well. The bladder normal on several cystoscopies.

G. H. S. Memorial Hospital, admitted August 5, 1920, male, aged 53 years. Cystoscopy showed a slightly bloody bladder tumor on left base near ureter 2 bladder tubes of radon 47 and 44 millicuries for 7 hours—637 millicurie hours—applied to tumor through cystoscope. Pathological examination suspicious of carcinoma. In May 1922 cystoscopy showed no tumor. In March, 1923 the patient reported well. No further report.

W. L. R. Memorial Hospital, admitted December 3, 1920, male, aged 70 years. Operation cystotomy a papillary partly bloody bladder tumor 2 1/4 by 3 centimeters on left side of base touching left urethra 19 bare tubes of radon 6 millicuries each—1504 millicurie hours—implanted in tumor 2 bladder tubes of radon 28 and 25 millicuries for 9 hours applied to surface. Pathological examination: papillary carcinoma Grade I. Patient died in 1935 of pneumonia. Up to time of his death he was free from symptoms.

P. W., Memorial Hospital, admitted November 20, 1921, male, aged 55 years. Operation cystotomy flat indurated bladder tumor 5 by 5 centimeters back of right ureter; 51 bare tubes of radon 17.56 millicuries—2301 millicurie hours—and 2 bladder tubes of radon applied to tumor. On May 22, 1923, 4 bare tubes of radon 3.63 millicuries—479 millicurie hours—applied to tumor through cystoscope. Pathological examination papillary carcinoma. In April, 1927 phosphates removed no tumor. Patient died in October 1927, from bladder and kidney infection.

W. H. M., Memorial Hospital, admitted December 10, 1920, male, aged 50 years. Operation cystotomy large, hard bladder tumor 4 by 3 centimeters

on anterior wall touching urethra 14 bare tubes of radon for 7 millicuries—924 millicurie hours—and 7 bare tubes of radon 2.45 millicuries—323 millicurie hours—and 3 bladder tubes of radon—430 millicurie hours—applied to tumor. Pathological examination squamous infiltrating carcinoma. On December 21 1922 cystotomy done for bladder stone, no tumor. In 1933 the patient is well.

A. V. Memorial Hospital, admitted April 30 1921 male, aged 45 years. Cystoscopy showed a solid partly sloughy bladder tumor 3 by 2½ centimeters on left lateral wall and above left ureter bladder tubes of radon 300 millicuries unscreened—100 millicurie hours—applied to tumor this was twice repeated. In 1933 slight recurrence treated by radium. Carcinoma Registry October 24, 1932, papillary carcinoma Grade II, radioresistant. In 1933 the patient had a normal bladder on cystoscopy.

W. N. L., Memorial Hospital, admitted June 14, 1921 male, aged 78 years. Cystoscopy showed papillary bladder tumor occupying entire right wall. On June 20 1921 1 bladder tube of radon 25 millicuries for 7 hours—175 millicurie hours—applied to tumor through cystoscopy. On August 4, 1921, a cystotomy was done and 20 bare tubes of screened radon 7.84 millicurie—1034 millicurie hours—implanted in tumor. Pathological examination papillary carcinoma. The patient was well up to 1929 when he died of pneumonia.

A. W. Lenox Hill Hospital, admitted October 1921 male, aged 58 years. Operation cystotomy a hard solid bladder tumor 3 by 3 by 3 centimeters on left bladder neck and running into urethra, 40 bare tubes of radon 8 millicurie each—4,424 millicurie hours—and 2 bladder tubes applied to tumor. Pathological examination infiltrating carcinoma (Mandelbaum). He had several small papillomata of the bladder in 1927 which were treated by fulguration. In 1932 the patient is well.

J. B. Memorial Hospital, admitted February 4 1922 female aged 63 years. Cystoscopy showed an extensive papillary bladder tumor with a base 4 by 4 centimeters back of right ureter and over trigone 3 bladder tubes of radon 110 millicuries—550 millicurie hours—applied cystoscopically to tumor and on nine subsequent times radium was implanted cystoscopically or held against the tumor the last treatment being given December 30 1923. Pathological examination simple papilloma. Carcinoma Registry papillary carcinoma Grade II Broders (Ewing) arrangement too atypical for simple papilloma. On March 25 1927 the patient had a normal bladder on cystoscopy. In March 1933 the patient is partly paralyzed arterial disease.

J. B. H., Memorial Hospital, admitted March 11 1922 female aged 53 years. Cystoscopy showed a sloughy bladder tumor 3 by 3 centimeters on left wall near left ureter. On March 21, 1923, 5 bare tubes of radon 5 millicuries—660 millicurie hours—implanted in tumor and on April 18, 1922 4 bare tubes of radon 4.32 millicuries—569 millicurie hours—implanted in tumor. Pathological examination: papil-

lary carcinoma. Carcinoma Registry squamous cell carcinoma, Grade III. In February 1933 the patient is well and tumor free on cystoscopy.

L. B. Memorial Hospital, admitted May 6 1922 female, aged 45 years. Cystoscopy showed a papillary sloughy bladder tumor 2 by 2 centimeters on left base. Cystoscopic applications of bare tubes of radon on eleven different times. Pathological examination infiltrating carcinoma. Carcinoma Registry papillary squamous carcinoma, Grade III (tissue not satisfactory for accurate grading). On November 23 1926 the patient was tumor free on cystoscopy. On April 7, 1931 a large mass appeared in epigastrium. This was thought to be metastasis from bladder. After death a punch biopsy of the mass was reported (Stewart) cannot make positive diagnosis, suggests adenocarcinoma (bile ducts) rather than bladder cancer.

W. H. M. Memorial Hospital, admitted June 6 1922 male, aged 65 years. Operation cystotomy sloughy bladder tumor 1½ by 2 centimeters on right bladder neck and trigone, 10 bare tubes of radon 1 millicurie each—1,320 millicurie hours—implanted in tumor. Pathological examination infiltrating papillary carcinoma. On January 5 1933 the patient is well.

C. McC. Memorial Hospital, admitted August 22 1922 male, aged 63 years. Cystoscopy showed three papillary bladder tumors, one 3 by 3 centimeters one 2 by 1 centimeter over base, and one 4 by 4 centimeters in urethral orifice. These were treated through the cystoscopy with bare tubes of radon. On October 5 1922 a cystotomy was done and 41 bare tubes of radon 23 8 millicuries—3 141 millicurie hours—implanted in tumor on May 1 1923 recurrence implanted with bare tubes of radon through cystoscopy. Pathological examination papilloma with cell changes and a tendency to infiltrate. Carcinoma Registry October 21 1932 papillary carcinoma, Grade II radioresistant. On February 27 1931 the patient died as the result of a bladder infection, bed heart, and uremia. He had suprapubic drainage off and on until death. The bladder showed no tumor on cystoscopy.

J. W. McT. Memorial Hospital No 33036 admitted January 1 1923 male, aged 64 years. Cystoscopy showed a large sloughy tumor 2½ by 2½ centimeters on left bladder neck, 6 seeds of radon 1.06 millicuries each—839 millicurie hours—implanted in tumor on May 8 1923 3 seeds of radon 2.49 millicuries each—330 millicurie hours—implanted in tumor through cystoscopy. Pathological examination papilloma. Carcinoma Registry papillary carcinoma Grade II (Broders) cells degenerated radioresistant October 21 1930. On January 2 1933 the patient is tumor free on cystoscopy.

M. C. Memorial Hospital admitted January 30 1923 male aged 46 years. One year previous resection of bladder at another hospital for papillary carcinoma. This recurred and he showed on cystoscopy a flat bladder tumor 2 by 2 centimeters on right lateral wall. On several occasions radium was

applied to the tumor through the cystoscope and finally a cystotomy was done and a residual tumor 2 by 2 centimeters on left lateral wall was implanted with radium. Pathological examination none of recurrence. In 1932 the patient has a normal bladder on cystoscopy.

C. D. Memorial Hospital, admitted June 19, 1923, male, aged 62 years. Operation cystotomy, infiltrating bladder tumor 2 by 2 centimeters back of right ureter. 16 bare tubes of radon 13.78 millicuries of 1818.96 millicurie hours implanted in tumor and 3 bladder tubes of radon 143.5 millicuries for 8 hours—430.5 millicurie hours—applied to tumor. Pathological examination adenocarcinoma (not like bladder, look for kidney or intestinal Ewing). In 1928 the patient was well and died in June 1930 of apoplexy.

D. K. Memorial Hospital, admitted July 6, 1923, male, aged 61 years. Operation cystotomy two bladder tumors near ureters extend submucously 2 by 1 centimeters. 20 bare tubes of radon 20 millicuries—2640 millicurie hours—implanted into tumors and 3 bladder tubes of radon 30 millicuries for 7 hours—420 millicurie hours—applied to surface. This tumor probably originated in the prostate. It was treated before and after cystotomy by radium. Pathological examination cylindrical cell carcinoma papillary and infiltrating. The bladder tumor was controlled, but the patient died of lobar pneumonia on November 26, 1928.

C. C. S. Memorial Hospital, admitted November 21, 1923, male aged 52 years. Operation cystotomy a solid papillary extensive bladder tumor on trigone extending laterally implanted with bare radon seeds. Pathological examination papillary carcinoma, beginning infiltration cellular. On March 15, 1927 the patient was tumor free on cystoscopy had a vesicorectal fistula. Died October 16, 1927 cause unknown.

A. K. Memorial Hospital, admitted March 11, 1924, male, aged 70 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 2 by 3 centimeters on base, 15 bare seeds of radon 8 millicurie—1584 millicurie hours—implanted in tumor and 4 bladder tubes 137 millicuries for 5 1/4 hours—753 millicurie hours—applied to tumor. Pathological examination epithelial papilloma. Carcinoma Registry November 4, 1931 papillary squamous carcinoma Grade II atypical. On July 16, 1932 the patient died at Long Island City Hospital from obstruction of left ureter uremia. No right kidney present at autopsy.

A. B., Memorial Hospital admitted May 6, 1924, male, aged 51 years. Operation: cystotomy spinal anesthesia, bladder tumor papillary 4 by 3 centimeters near right ureter. 7 bare tubes of radon 53 millicurie—483 millicurie hours—and 3 bladder tubes 131 millicuries for 7 hours—917 millicurie hours—applied to tumor. On June 4, 1926, 3 gold tubes of radon 1.76 millicuries—696.9 millicurie hours—applied to recurrence. Pathological examination papilloma, cells atypical but orderly. On January 6

1933 the patient has a normal bladder on cystoscopy.

H. J. Memorial Hospital, No. 34067 admitted on November 12, 1924, female, aged 60 years. Operation cystotomy spinal anesthesia, bladder tumor papillary sloughy 8 by 5 centimeters on base and either lateral walls near internal urethra. 31 bare seeds of radon of 70.77 and 63 millicurie—455 millicurie hours—implanted in tumor. Pathological examination probably remains of infiltrating carcinoma. Carcinoma Registry infiltrating carcinoma probably Broders Grade IV radioresistant. On March 7, 1933 the patient had a normal bladder on cystoscopy.

N. W. Memorial Hospital No. 34364, admitted on January 6, 1925, male aged 50 years. Operation cystotomy, spinal anesthesia, bladder tumor low papillary 6 by 5 centimeters on left base. 39 gold radon seeds of 68 and 78 millicurie each—3598 millicurie hours—implanted in tumor and 3 bladder tubes of radon screened by 1/4 millimeter silver 47.55 and 53 millicuries for 4 1/4 hours—6975 millicurie hours—applied to tumor. Pathological examination infiltrating carcinoma. Carcinoma Registry November 4, 1931, papillary squamous carcinoma, Grade II. On February 9, 1929 the patient had no bladder tumor on cystoscopy. On March 1, 1931 the patient was in fine shape. Died on May 20, 1931 cause unknown.

Dr. M. C. S. Memorial Hospital, admitted February 24, 1925, female, aged 56 years. Cystoscopy flat bladder tumor 2 by 2 centimeters on left margin of trigone, 5 gold seeds of radon 5 millicuries—660 millicurie hours—implanted in tumor through cystoscope. On June 9, 1925 5 gold seeds 75 millicuries each—645 millicurie hours—implanted in tumor. On June 22, 1926 166 millicuries unscreened radon applied to tumor for 20 minutes. Pathological examination infiltrating carcinoma. On November 1, 1932 the patient is well and tumor free.

J. R. Memorial Hospital, admitted March 21, 1925, male, aged 46 years. Operation cystotomy bladder tumor 4 by 6 centimeters over bladder base and urethral orifice. 31 bare tubes of radon 84 millicurie each—3437.28 millicurie hours—implanted in tumor and 3 bladder tubes of radon 123 millicuries for 6 hours—750 millicurie hours—applied to tumor. Pathological examination infiltrating carcinoma, atypical cells. Carcinoma Registry papillary carcinoma, Grade II radioresistant. The patient died in 1932 of myocarditis.

I. W., Memorial Hospital, No. 34722 admitted April 28, 1925, male aged 57 years. Operation Cystotomy spinal anesthesia, bladder tumor papillary 2 by 2 centimeters on bladder base. 15 bare tubes of radon 8.10 millicuries—1269 millicurie hours—implanted. Pathological examination infiltrating carcinoma. Carcinoma Registry December 1, 1929, papillary squamous cell carcinoma, Grade III. On January 8, 1932 specimen taken cystoscopically shows no tumor. March 19, 1933 the patient is well and at work.

J H Memorial Hospital, admitted June 2 1925 female aged 66 years. Cystoscopy bladder tumor papillary 3 by 2 centimeters back of left ureter 5 bare tubes of radon 3 15 millicuries—415 80 millicurie hours—applied to tumor On June 14 1925, 7 bare tubes of radon 3 91 millicuries—546 68 millicurie hours—applied to tumor through cystoscope. Pathological examination papillary carcinoma. Carcinoma Registry December 1 1930 squamous cell papillary carcinoma, Grade II On May 12 1931 the patient was free from tumor on cystoscopy Died in February 1932, suddenly from arterial disease.

A. C. C. Memorial Hospital, admitted July 20 1925 male, aged 68 years. Cystoscopy sloughy bladder tumor 2 by 1 centimeters on base. On two different times unscreened radon was held against the tumor and the growth controlled. In April 1927, a cystotomy was done for recurrence under spinal anesthesia, 10 gold radon seeds 20 millicuries—2640 millicurie hours—implanted. Pathological examination suspicious of carcinoma, superficial. Carcinoma Registry October 30 1932 papillary carcinoma, Grade II infiltrating radioresistant. In March 1933 the patient is in good condition.

J B B Memorial Hospital admitted July 24, 1925 male aged 50 years. Operation cystotomy spinal anesthesia, bladder tumor papillary 3 by 3 centimeters on bladder neck radium implantation. Pathological examination papillary carcinoma. Carcinoma Registry October 20 1932 papillary carcinoma, Grade II Broders (Ewing 1) radioresistant. On September 27 1933 the patient had a normal bladder on cystoscopy.

D S, Memorial Hospital, admitted October 13 1925 male, 60 years. Operation cystotomy spinal anesthesia, 3 papillary bladder tumors on base and lateral walls 4 by 4 centimeters, 6 by 8 centimeters, and 4 by 4 centimeters 80 square centimeters indurated 16 gold radon seeds 40 83 millicuries—5389 56 millicurie hours—were implanted in tumors. On several subsequent times tubes of screened radon were applied to the tumors. Pathological examination papilloma cells somewhat atypical. Carcinoma Registry October 11 1931 papillary squamous carcinoma, Grade I. On January 31 1933 the patient was in excellent health.

J B K. Memorial Hospital No 35759 admitted February 12 1926 male, aged 60 years. Operation cystotomy, spinal anesthesia bladder tumor 2 by 1 centimeters on trigone and internal urethra 7 gold radon seeds 2 millicuries each—1848 millicurie hours—implanted in tumor also 2 bladder tubes of radon 36 and 42 millicuries for 4½ hours—351 millicurie hours—applied in bladder base. Pathological examination papilloma. Carcinoma Registry papillary squamous carcinoma Grade I. On May 12 1931 recurrence at top of bladder radium applied through cystoscope and fulgurated Also on several later occasions. In March 1932 the patient was tumor free on cystoscopy On August 26 1932 the patient died suddenly of a heart attack.

Y W Memorial Hospital admitted May 7 1926, female aged 70 years. Operation cystotomy spinal anesthesia, bladder tumor papillary 2 by 1 centimeters on base 6 gold radon seeds 10 50 millicuries—1356 millicurie hours—implanted in tumor Pathological examination papillary carcinoma Carcinoma Registry October 24, 1932 papillary carcinoma, Grade III radioresistant On October 20 1932 the patient was in excellent condition.

Z T Memorial Hospital admitted May 22 1926 male, aged 53 years. Operation cystotomy a papillary bladder tumor 3 by 2 centimeters on right trigone and smaller growths 8 gold radon seeds 12 80 millicuries—1689 millicurie hours—implanted in tumor On July 30 1926 2 bladder tubes 80 millicuries for 7 hours—613 millicurie hours—applied to tumor On December 12 1926 1 gold radon seed 2 millicuries—364 millicurie hours—applied through cystoscope to slight recurrence superficially to tumor Pathological examination epithelial papilloma, cells atypical. Carcinoma Registry papillary squamous carcinoma, Grade II On April 5, 1929 cystoscopy showed bladder calculus, no tumor On June 16 1929 the patient died from infection of the genitourinary tract.

R S Memorial Hospital, admitted November 16 1926 female, aged 50 years. Operation cystotomy spinal anesthesia bladder tumor papillary 3 by 2 centimeters on base and left trigone 10 gold tubes of radon 25 5 millicuries—3366 millicurie hours—implanted into the tumor Pathological examination epithelial papilloma, cells very atypical. Carcinoma Registry October 11 1933 papillary squamous carcinoma, Grade II. On January 26 1932 the patient had no tumor on cystoscopy In February 1933 the patient is well.

C S Memorial Hospital, No 37019 admitted February 1 1927, male, aged 47 years. Operation cystotomy spinal anesthesia bladder tumor papillary 2 by 3 centimeters on base 14 gold radon seeds 28 millicuries—3696 millicurie hours—implanted into the tumor Also course of deep X ray Pathological examination solid papillary carcinoma. Carcinoma Registry papillary squamous carcinoma, Grade I On July 25 1930 the patient was tumor free and had a normal bladder on cystoscopy On January 8 1931, the patient died of pulmonary tuberculosis.

G H Memorial Hospital No 37227 admitted April 3 1927 male, aged 59 years. Operation cystotomy spinal anesthesia sessile tumor 5 by 6 centimeters on bladder base 22 gold radon seeds, 53 03 millicuries—7053 millicurie hours—implanted in the tumor Pathological examination infiltrating epidermoid carcinoma Carcinoma Registry November 24 1930 squamous cell papillary carcinoma, Grade III On October 11 1932 the patient reports he is perfectly well and has no bladder trouble.

B S Memorial Hospital No 37384 admitted May 17 1927 male, aged 52 years. On March 9 1927 cystotomy and cautery at another hospital for a large bladder tumor Cystoscopy on May 24, 1927 spinal anesthesia 8 gold radon seeds 16 64 millicuries

—2916 millicurie hours—implanted in tumor. On July 1, 1927, 5 gold radon seeds 14.30 millicuries—1837 millicurie hours—implanted through cystoscope. Patient also had many courses of deep x-ray. Pathological examination epithelial papilloma. Carcinoma Registry papillary squamous cell carcinoma, Grade I. On May 10, 1933, the suprapubic sinus still leaking the patient is in fair condition.

H. E. N. Memorial Hospital, No. 37812 admitted September 13, 1927, male, aged 56 years. Operation cystotomy spinal anesthesia, bladder tumor papillary 5 by 6 centimeters on trigone between ureters, 26 gold radon seeds 58.24 millicuries—7745 millicurie hours—implanted in tumor. Pathological examination epidermoid carcinoma cell atypical. Carcinoma Registry April 20, 1931 squamous cell carcinoma Grade III. On March 10, 1933 the patient has a normal bladder on cystoscopy.

M. T. B., Memorial Hospital, No. 36445 admitted April 10, 1928, female, aged 70 years. Cystoscopy spinal anesthesia, papillary bladder tumor 2 by 1 centimeters on right wall, 5 gold radon seeds 5 millicuries—6000 millicurie hours—implanted in tumor. On August 21, 1928 250 millicuries of unscreened radon held against the tumor for 1 hour through the cystoscope under spinal anesthesia. On October 22, 1929 cystoscopy showed 2 bladder tumors, 1 small and 1 larger, 5 gold radon seeds 11.70 millicuries—6000 millicurie hours—implanted in the tumors. On December 4, 1929, 298 millicuries of unscreened radon held against the tumor for 1 hour through the cystoscope under spinal anesthesia. Pathological examination papillary carcinoma, cells very atypical. Carcinoma Registry October 20, 1932, papillary carcinoma, Grade II, radioresistant. On November 7, 1931 the patient had a clean bladder on cystoscopy and in April, 1933, the patient is well.

A. C. Memorial Hospital, No. 37341, admitted May 8, 1928, female, aged 43 years. The patient has had an advanced carcinoma of the cervix treated by radium. Operation cystotomy spinal anesthesia, bladder tumor 4 by 4 centimeters on base posterior to trigone, 5 gold radon seeds 9.30 millicuries—6000 millicurie hours—were implanted in tumor. Also treated with external radiation. Pathological examination infiltrating carcinoma, bladder superficial. On June 10, 1932 the patient had a normal bladder on cystoscopy, on February 1, 1933, specimen taken from the bladder, no tumor.

S. R., Memorial Hospital, No. 39032, admitted August 27, 1928, male, aged 50 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 1 by 1 centimeter on base involving part of trigone, 9 gold radon seeds 18 millicuries—23.76 millicurie hours—implanted in tumor. Pathological examination papillary epidermoid carcinoma radioresistant. Carcinoma Registry December 1, 1930, squamous cell carcinoma, papillary Grade I. On July 5, 1932 the patient had a normal bladder on cystoscopy on December 2, 1932 the patient is well.

A. P. Memorial Hospital, No. 34185, admitted September 27, 1928, female, aged 46 years. Patient

was in the Gynecological Service with advanced primary carcinoma of the cervix. Cystoscopy spinal anesthesia showed bladder tumor papillary and infiltrated 2 centimeters on base posterior to the trigone. On July 7, 1928 5 gold radon seeds 10 millicuries—1320 millicurie hours—implanted in tumor cystoscopically. On August 14, 1928, 3 gold radon seeds 7.5 millicuries—900 millicurie hours—implanted cystoscopically. Pathological examination infiltrating squamous carcinoma. On January 27, 1933 the patient has a normal bladder on cystoscopy.

C. A. W., Memorial Hospital, No. 39563, admitted January 9, 1929, male. Operation cystotomy spinal anesthesia, papillary bladder tumor 1.5 by 1.5 centimeters on right lateral wall, 10 gold radon seeds implanted in tumor. Pathological examination epidermoid carcinoma, Grade I-II, radioresistant. Carcinoma Registry December 1, 1930, squamous cell infiltrating with keratinization, Grade III. On October 25, 1932 the patient had a normal bladder on cystoscopy.

O. H., Fifth Avenue Hospital, No. 37461, admitted January 17, 1929, female, aged 51 years. Operation cystotomy general anesthesia, bladder tumor 3 by 4 centimeters on right lateral wall, 18 gold seeds of radon 49.50 millicuries—6434 millicurie hours—implanted in the tumor. Pathological examination (Memorial Hospital) infiltrating epidermoid carcinoma. In August, 1932 the patient reported as being well.

E. S. Memorial Hospital No. 39718, admitted February 10, 1929, female, aged 56 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 3 by 2 centimeters on left lateral wall, 14 gold radon seeds 8 millicuries—4006 millicurie hours—implanted in the tumor. Pathological examination papilloma with very suspicious carcinoma changes. Recurrence on January 28, 1930, under spinal anesthesia 4 gold radon seeds 8 millicuries—1056 millicurie hours—implanted in the tumor through cystoscope. In March, 1933 the patient had no tumor on cystoscopy.

G. L. V. Memorial Hospital, No. 39367, admitted April 2, 1929, male. Operation cystotomy spinal anesthesia, large infiltrating growth of the prostate involving the bladder, 20 gold radon seeds 60 millicuries—11700 millicurie hours—implanted in the tumor. Pathological examination infiltrating carcinoma, Grade II, radioresistant, primary bladder. On February 4, 1930 the patient had no tumor on cystoscopy. On February 3, 1933 the patient is in good condition.

M. C., Fifth Avenue Hospital No. 39249, admitted April 24, 1929, male, aged 69 years. Operation cystotomy spinal anesthesia, bladder tumor solid and sloughy 3 by 3 centimeters on right base and right ureter, 10 gold radon seeds 2 millicuries and 2 gold radon seeds 2.19 millicuries, 24.38 millicuries—3818 millicurie hours—implanted in tumor. Pathological examination infiltrating carcinoma, "large round cells invading muscularis, mitoses present. In April, 1933 the patient is in good condition.

J N, Fifth Avenue Hospital, No 46861 admitted July 16, 1930, male, aged 60 years. Operation cystotomy, spinal anesthesia, hard papillary and infiltrating tumor 6 by 4 centimeters on left base running up anterior and lateral base, 20 gold radon seeds—5280 millicurie hours—implanted into the tumor base. Pathological examination infiltrating carcinoma, anaplasia, and mitosis. In January, 1933 the patient had a normal bladder on cystoscopy. In April, 1933 the patient is well.

A S, Fifth Avenue Hospital No 49936, admitted February 3, 1931, male, aged 63 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 2 by 2 centimeters on right base 13 gold radon seeds 20.8 millicuries—2745 millicurie hours—implanted into the tumor base. Pathological examination papillary carcinoma, anaplasia, and many mitoses. In March, 1933 the patient has a normal bladder on cystoscopy.

M J B Memorial Hospital, No 43275, admitted June 16, 1931 male, aged 58 years. Operation cystotomy, spinal anesthesia, three papillary bladder tumors not infiltrating at internal urethra and base 16 gold radon seeds 17.34 millicuries—2288 millicurie hours—implanted into the tumors. Pathological examination papilloma cellular and actively growing carcinoma. Carcinoma Registry October 11 1931, papillary squamous carcinoma, Grade I. On January 24, 1933 the patient is well and has a normal bladder on cystoscopy.

A L, Memorial Hospital, No 43287 admitted June 18 1931 male, aged 51 years. Operation cystotomy, spinal anesthesia, papillary bladder tumor 4 by 4 centimeters on left anterior wall going up to left ureter 27 gold radon seeds 51.51 millicuries—6798 millicurie hours—implanted into the tumor. Pathological examination papillary and infiltrating epidermoid carcinoma (opaque squamous cells) Grade III, radioresistant. Carcinoma Registry October 11, 1931 papillary squamous carcinoma, Grade III. On October 26 1932 the patient is in excellent condition, no cystoscopic examination.

F D, Memorial Hospital No 43520, admitted August 4 1931 male, aged 56 years. Operation cystotomy, spinal anesthesia, bladder tumor 3 by 3 centimeters on midline 3 centimeters posterior to trigone 8 gold radon seeds 12 millicuries—1596 millicurie hours—implanted in tumor base. Pathological examination epithelial papilloma. Carcinoma Registry July 19 1932 papillary carcinoma, Grade II (Broders), Ewing Grade I radioresistant. On May 9, 1933 the patient has a normal bladder on cystoscopy.

P H, Memorial Hospital No 40021 admitted May 14 1929, male aged 69 years. Operation cystotomy, spinal anesthesia, 2 papillary sloughy bladder tumors, one 5 by 6 centimeters on right lateral wall, another adjoining 2 by 2 centimeters 19 gold radon seeds 63.5 millicuries—8466 millicurie hours—implanted into the tumors. Pathological examination papillary epidermoid carcinoma, Grade II, radioresistant. Carcinoma Registry November 24

1930 papillary squamous carcinoma, Grade II. On September 20, 1932, the patient had a normal bladder on cystoscopy.

E A J, Memorial Hospital, No 40436, admitted August 20, 1929 female aged 63 years. Operation cystotomy, spinal anesthesia, papillary bladder tumor 3 by 2 centimeters on lateral right wall above the right ureter, 16 gold radon seeds 30 millicuries—3990 millicurie hours—implanted into the tumor. Pathological examination epidermoid carcinoma, small cells radioresistant. Carcinoma Registry December 1, 1930 squamous cell carcinoma Grade III. On March 19, 1933 the patient had a normal bladder on cystoscopy.

J P T, Memorial Hospital, No 40574, admitted September 24 1929 male, aged 51 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 5 by 4 centimeters on left wall and smaller tumor 1 by 1 centimeter over ureter 23 gold radon seeds 48 millicuries—6384 millicurie hours—implanted into the tumors. Pathological examination epidermoid carcinoma, Grade II, radioresistant. Carcinoma Registry December 1 1930, papillary carcinoma, Grade II. On November 4, 1932, the patient had a normal bladder on cystoscopy.

E H, Memorial Hospital admitted November 19 1929, female aged 64 years. Operation cystotomy, spinal anesthesia papillary bladder tumor 4 by 4 centimeters on left lateral wall 25 gold radon seeds 57.24 millicuries—7632 millicurie hours—implanted into the tumor. Pathological examination cellular papillary epidermoid carcinoma Grade II radioresistant. Carcinoma Registry December 1 1930 papillary carcinoma, Grade III. On November 15 1932, the patient has a normal bladder on cystoscopy. In March, 1933 the patient is well.

C D F, Mary McClellan Hospital, admitted April 29 1930 male, aged 56 years. Operation prostatectomy suprapubic, for benign prostate. In addition, he had a bladder tumor 3 by 1 centimeters on right base 2 bladder tubes of radon were fixed to the bladder and removed subsequently. Pathological examination cellular epidermoid carcinoma which infiltrates. Anaplastic, Grade III radioresistant. On November 4 1932 the patient was well.

U P H Memorial Hospital No 43655 admitted September 2 1931 male, aged 62 years. Operation cystotomy, spinal anesthesia, ulcerated bladder tumor 6 by 6 centimeters on right trigone surrounding right ureter 23 gold radon seeds 27.9 millicuries—3710 millicurie hours—implanted into the tumor base. Pathological examination simple papilloma. Carcinoma Registry papillary squamous carcinoma Grade II. On September 6 1932 the patient was well and had a normal bladder on cystoscopy.

J C B Memorial Hospital, No 43700 admitted September 15 1931 male, aged 58 years. Operation cystotomy spinal anesthesia, bladder tumor 4 by 4 centimeters over the right ureter 37 gold radon seeds 55.25 millicuries—7348 millicurie hours—implanted into the tumor base. Pathological examination epidermoid carcinoma, Grade III. Carcinoma

Registry October 20 1932 infiltrating carcinoma, Grade III radiosensitive. On November 8 1932 the patient is well and has a normal bladder on cystoscopy.

A. M. H. Memorial Hospital, No. 44385 admitted February 9, 1932 female aged 50 years. Operation cystotomy spinal anesthesia extensive bladder tumor 6 by 3 centimeters on base and around bladder neck extending nearly up to either ureter and a small tumor at the apex of the bladder. 51 gold seeds of radon 76 millicuries—10103 millicurie hours—implanted into the tumors. Pathological examination vascular papillary epidermoid carcinoma, Grade I radioresistant. Carcinoma Registry October 20 1932 papillary carcinoma Grade II, Broders (Ewing I). February 16 1933 the patient had a normal bladder on cystoscopy.

H. B. Memorial Hospital, No. 44384 admitted February 9 1932 male aged 42 years. Operation cystotomy spinal anesthesia bladder tumor 6 by 6 centimeters on base and most of trigone. 26 gold radon seeds 45.96 millicuries—6118 millicurie hours—implanted into the tumor. Pathological examination papillary epidermoid carcinoma, Grade I radioresistant. Carcinoma Registry papillary carcinoma, Grade II, Broders (Ewing I) radioresistant. On February 28, 1933 the patient had no tumor on cystoscopy, some congestion.

L. G. Memorial Hospital, admitted July 5 1932 female, aged 56 years. Cystoscopy spinal anesthesia, several sessile solid bladder tumors on the vault, one was 1 centimeters in diameter. 23 gold radon seeds 41.53 millicuries—5481 millicurie hours—implanted into the tumors on 7 cystoscopies. Pathological examination squamous carcinoma, Grade II, radioresistant. On March 10, 1933 the patient had a normal bladder on cystoscopy.

G. A. M. Memorial Hospital, No. 45177 admitted July 16, 1932 male aged 66 years. Operation cystotomy spinal anesthesia 2 sloughy bladder tumors, 1 near right ureter 3 by 2 centimeters, second tumor near urethral orifice 2 by 2 centimeters. 12 gold radon seeds 16.2 millicuries—2169 millicurie

hours—implanted into the tumors. Pathological examination epidermoid carcinoma, Grade II radioresistant. On January 17 1933, the patient has a normal bladder no tumor slight radium ulcer on cystoscopy. In April, 1933 patient continues well.

A. A. K. Memorial Hospital, No. 45651 admitted November 8, 1932 male, aged 53 years. Cystoscopy spinal anesthesia, solid papillary bladder tumor 1 centimeter square on right base over left ureter. 4 gold seeds 7.80 millicuries—1182 millicurie hours—implanted in tumor. Pathological examination papillary epidermoid carcinoma, Grade II radioresistant. On March 2 1933 the patient had a normal bladder on cystoscopy.

P. W. B. Memorial Hospital, No. 45775, admitted December 5 1932 male, aged 56 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 3 by 4 centimeters on base going up to both ureters. 16 gold radon seeds 22.83 millicuries—3050 millicurie hours—implanted into the tumor. Pathological examination papillary epidermoid carcinoma, Grade I. On March 14, 1933 the patient was in good condition. Cystoscopy shows no tumor slight slough.

A. R. Memorial Hospital, No. 45779 admitted December 6 1932 male, aged 55 years. Operation cystotomy spinal anesthesia, papillary bladder tumor 1 by 2 centimeters on right bladder neck, 3 gold radon seeds 4.5 millicuries—700 millicurie hours—implanted into the tumor. Pathological examination papillary on surface base atypical, early carcinoma, limited degree of infiltration. In April, 1933, the bladder shows no tumor on cystoscopy but a slight slough in bladder neck.

E. D. Memorial Hospital, admitted December 27 1932 female, aged 75 years. Cystoscopy sessile sloughy bladder tumor 4 centimeters in diameter in vault of bladder. 6 gold radon seeds 10.60 millicuries—1409.80 millicurie hours—implanted into the tumor through the cystoscope. Pathological examination epidermoid carcinoma, Grade II radioresistant. On February 28 1933 the patient had no tumor on cystoscopy.

# CLINICAL SURGERY

FROM THE BARNARD FREE SKIN AND CANCER HOSPITAL

## COMBINED INTRA-ABDOMINAL AND INTRAVAGINAL RADIUM TREATMENT IN CANCER OF THE CERVIX<sup>1</sup>

GEORGE GELLHORN M D F A C S St Louis, Missouri

IN order to improve the results of radium treatment of advanced cancer of the cervix, I wish to suggest a technique which aims at placing the cancerous area between two fires.

The abdomen is opened by a midline incision, the intestines are packed away and the pelvic cavity is exposed to sight and touch. Traumatization is carefully avoided and adhesions are severed and organs removed only in so far as they interfere with thorough exposure.

The operator now inserts the index and middle fingers of his left hand (if this be the one which he habitually uses for examination) *beneath the sterile drapings* into the vagina, and proceeds to a bimanual examination with the other still sterile hand inside the pelvic cavity. It is astonishing how much one can learn by this sort of examination. To begin with, the extension of the cancer is almost always found to be considerably greater than was assumed before the operation. Even a very insignificant progress into the broad ligaments beyond the confines of the cervix can readily be detected. Isolated lymph nodes or cords can well be felt. The degree to which the rectovaginal and, even more, the vesicovaginal septum is involved can plainly be ascertained.

After this exploration which should not be done too hurriedly gold seeds containing radium emanation are inserted beneath the peritoneum in such a way that these seeds form a complete ring around the periphery of the cancerous area. The guiding fingers in the vagina not only help in selecting the places where the radons are to be introduced but also make it possible to gauge the exact depth to which the needles have to be pushed. Particular attention is given to the iliac triangle with its glands, the vesicovaginal septum, the sacro-uterine ligaments, the small gland between ureter and uterine artery, etc. Each needle remains in place until all of them have been inserted.

The operator now withdraws from the operating table, an assistant pulls out the needles and closes the abdomen.

The patient is next put in lithotomy position. The operator inserts one or more capsules containing radium substance into the uterine cavity and radium needles into the tumor itself, particularly its outer edge. Figure 1 shows the distribution of the various radium applicators immediately after removal of the patient from the operating table.

The amount of radium used in the entire procedure is somewhat variable. We hesitated at first to use more than 2500 milligram hours in all. With growing experience it became clear that larger quantities did no harm and at present we have chosen an arbitrary average of from 4200 to 4500 milligram hours. Of this amount of radioactivity more than one half resides in the gold seeds of which, as a rule, 14 are implanted. Each seed contains 15 millicuries and 1 millicurie is equivalent to 132 milligram hours; the 14 seeds correspond roughly to 2800 milligram hours. The balance is applied in the form of capsules and needles, and it is easy to compute the amount needed to make up the desired total. It goes without saying that the ratio between intra-abdominal and intravaginal radium may have to be changed in a given case. It should also be mentioned that, as a rule, the treatment is not repeated. Only a few times have we found it desirable to apply a small amount of radium locally, when the tumor of the cervix had not retrogressed completely.

The technique of the entire procedure is quite simple. The immediate recovery has been surprisingly smooth, considering the nature of our material and bearing in mind that all patients belonged to groups III and IV of the accepted classification. Contrary to expectations the nausea complained of was not much greater than is usually

<sup>1</sup>Read (by title) at a meeting of the American Gynecological Society held in Washington, May 2, 1931.





Fig. 1. Distribution of gold seeds and radium applicators immediately after removal of patient from operating table.

observed after intensive radium treatments. In not a single instance was the peritoneal reaction greater than after any laparotomy and it became obvious that the insertion of the seeds had caused no undue traumatism. It may be added here that the small gold seeds caused no disturbance later on. They produced no local necrosis nor did they set up an irritation as foreign bodies. As proof I insert Figure 2 which shows the gold seeds in place one year after operation.

Neither was wound healing disturbed, and all abdominal incisions healed by primary intention. I realize, however, that this pleasing circumstance is probably due to the small number of cases thus far treated. In a larger series we would undoubtedly have had the usual percentage of disturbed wound healing. An occasional complication, such as pyelitis or cystitis, did not differ either in frequency or severity from the common postoperative disturbances.

All patients but one survived the operation and left the hospital improved. The one fatality occurred in a patient who died from embolism when first sitting up after 12 days of undisturbed convalescence.



Fig. 2. The gold seeds in place one year after operation.

We see therefore that the procedure here proposed is relatively innocuous. But even in a desperate condition such as cancer no operation is justifiable unless it is vindicated by the final results. For this reason we have proceeded only very cautiously and performed the operation but a few times each year until the perspective of several years would allow us to gauge any differences from the customary radium treatment as it was carried out in the large majority of the cases.

Our material then, may be divided into two groups. Group A consists of the patients treated by the combined abdominovaginal method as already stated they were, without exception, in advanced stages of the disease. Group B is composed of all other patients treated merely by the vaginal route they represented not only advanced but also many borderline cases.

The results obtained are shown in Table I.

TABLE I—RESULTS

Group	Treated in 1930	Alive in 1932	Treated in '31	Alive in 1933
A	10 CASES	3 CASES	10 CASES	4 CASES
B	23 CASES	0 CASES	7 CASES	27 CASES

From this table it is seen that in spite of the enormous disparity of the number of patients in the two groups, the combined abdominovaginal approach upon the cancer has yielded highly encouraging results. These would probably have

been still better had we extended the method from the beginning to less advanced cases, and used larger quantities of radium from the start.

The patients treated last year are not included in these statistics because the time has been too short for us to draw any conclusions.

More recently we have added still another feature to this combined attack. We have first subjected the patient to a thorough abdominal X ray treatment, and have performed the abdomino-vaginal operation 3 weeks after the X ray treatment is finished. In this way we have hoped to affect the regional lymph glands and particularly

the more remote ones in such a way that they would not permit the passage of any cancerous material that might have been set in motion by the radium treatment. The combination with X ray treatment will perhaps result in the use of less radium than we have employed heretofore. It is too soon, however to speak of experiences along this line.

For the present I am content with calling attention to a technique which logically and by actual experience appears suited to improve the results of our treatment of advanced cancer of the cervix uteri.

## A PLEA FOR PROPHYLACTIC INTERVENTION IN THE SECOND STAGE OF LABOR

JAMES ROBERT GOODALL, O.B.E. B.A. M.D. C.M. D.Sc. F.C.O.G. F.A.C.S., MONTREAL  
 Gynecologist and Obstetrician to the Royal Victoria Montreal Maternity Clinical Professor of Gynecology and  
 Obstetrics at McGill University

THERE is not the slightest doubt that this article will meet with vigorous opposition from the proponents of conservative obstetrics. It is logical to place hospital obstetricians into two great groups: first, those who are advocates of a policy of *laissez faire* in which they play the part of glorified midwives, and second, those who, by training in both obstetrics and surgical gynecology endeavor to shorten the hours of labor by timely intervention. It pleases no one merely to make this arbitrary division of conscientious workers, but there is much to be said for and against each line of action. There is much to commend in this practice and many reservations to qualify and restrict the procedure. It is not in the nature of this paper to advocate wholeheartedly unqualified intervention, but rather to point out the many ways in which our methods of present day procedure might be improved, always keeping in mind the obstetrician's experience both obstetrically and surgically and the facilities at his command to carry out his intervention, if his individuality should incline him to that procedure. Whatever is stated hereafter is based upon a wide experience in obstetrics and gynecology at one time very decidedly conservative, now decidedly conservative of the parturient. The author's conclusions are drawn entirely from his private work. All his patients are hospital cases. Therefore circumstances were of the best. There were 10 years of a non-interference policy and 10 years of prophylactic intervention. There are four reasons for advocating a policy of discriminating intervention: (1) to reduce fatigue and prevent exhaustion, (2) to relieve the patient and shorten the labor, (3) to minimize the traumatism of the second stage, and (4) to lessen fetal mortality. One need not dwell upon the first two; they are self-explaining.

As regards the third reason, it is the author's firm conviction that most of the injuries conducive to a prolapse of pelvic organs trace their origin to the second stage of labor.

In the first stage there is merely an interaction of two forces, the active upper segment against the passive lower segment. There is no forcible displacement of organs except a gradual distention of the lower uterine segment toward the

pelvic frame. The whole of the first stage could take place as well outside the body as within it. It is merely an interaction of two forces, of which the woman is the victim through her sensory system. But during this period, in consequence of the approach of the uterine isthmuses to the pelvic wall, the normal uterine supports now become redundantly lax. This applies particularly to the pubo-uterine and sacro-uterine ligaments. But another factor of the greatest importance must be described. The stout portions of the pubo-uterine ligaments, and similarly of the sacro-uterine, in the non-pregnant state, find each an attachment of about one half inch to the corresponding bones. The other ends find an attachment of about similar dimensions to the cervix. The average circumference of the non-pregnant cervix is about 7 centimeters. To this circumference the four ligaments—two pubo-uterine and two utero-sacral—are attached. When on the other hand the cervix is fully dilated the average circumference is equal to about 36 centimeters. The uterine ends of these ligaments have therefore spread out to five times their quiescent state. The consequence is that each ligament starting from its bony attachment spreads out like the ribs of a palm fan, with portions thick and some very thin. The attachments are correspondingly weak at the succulent uterine end where the lower uterine segment is so soft as to be impalpably indistinguishable from the surrounding toneless structures (Fig. 1). Now as soon as dilatation of the cervix is completed, and the presenting part descends, it encounters the more easily dilated upper vaginal vault, and with each descent the retraction and force of the upper uterine segment is increased. The whole force of the contraction and retraction of the upper segment against the lower vagina and perineum is now borne by the uterine attachments—the pubo-sacral sling and the attachment of the lower uterine segment to the vagina augmented by the pelvic vascular system and whatever assistance the pelvic cellular tissues may add. For every ounce of resistance to the advancing presenting part there is a corresponding elongation of uterine attachments, and a corresponding rise of the uterus into the abdomen. Efforts at bearing down

in this stage tend to tear the ligamentous attachments of the pubo-uterine ligaments away from the cervix causing small interstitial hemorrhages which are easy to detect at autopsy in any recently delivered primipara. A full bladder during this period accentuates the damage not only in tearing away the uterine attachments but in separating the fibers of the pubo-uterine fan thereby initiating the first stages of a hernia of the bladder. The resultant of all these forces is that one sees, after a prolonged second stage, uteri that permit of an exaggerated elevation into the abdomen or an exaggerated prolapse so that the cervix protrudes from the vulva.

In view of the above, theoretically it cannot be but that any reduction of the stress of the second stage of labor must operate to the advantage of the mother's tissues not only abdominal but pelvic practically that is exactly what happens, when early intervention takes place under the ministrations of experienced hands and mature judgment. The author's policy invariably is to allow labor to progress, under methods of conservation of energy such as rest mitigation of pain elimination of fear and if possible conservation of the bag of waters until such time as the vulva is dilated to the size of 3 or 4 centimeters. Then the patient is fully anesthetized and after sterilization of the vulva the vaginal outlet is gently ironed out to admit the hand or most of the hand. This is done under a continuous small stream of sterilized green soap. In ternal rotation, if not completed is accelerated manually if possible. If not possible of accomplishment, forceps are applied in anterior position over the malar prominences. If the lie is a posterior one manual rotation will succeed in a goodly percentage of cases. In cases of failure the head is shoved up out of the pelvis and a Pomeroy or a Melhado maneuver is practiced. These rarely fail except in those long labors in cases of primary inertia with early rupture of the bag of waters and slow complete draining away of the after waters. In such cases the uterus may mold itself so closely about the child and particularly about its shoulders that rotation is impossible. In these cases and in these only forceps are applied in any position of the head and delivery effected a lowing rotation of the occiput anteriorly or posteriorly as the inclination of the case may be. These are the dangerous forceps cases because of the great cephalic molding and the close coaptation of the mother's tissues about the presenting part makes a perfect application of the forceps almost impossible. The French school does not recognize any application of the forceps

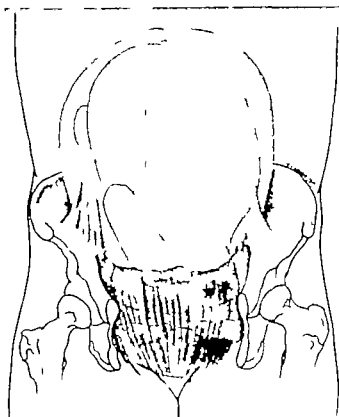


Fig 1 separation of fibers of anterior vaginal wall by the descending head. Note the fan-like separation with alternate ribs and webs. Dissection by Dr A. D. Campbell, McGill University Montreal.

other than the bimalar. This is the one application that is practically free from danger to the child. In every other type of application the author always feels a great anxiety for the life of the unborn. When the head is drawn down and the perineum is put upon the stretch it is incised with the scissors in the midline and delivery is completed slowly by combined forceps and the full right hand covered with a cloth compressing the perineum with the fingers on the patient's right and the thumb on the left of the fetal head thereby hastening extension of the presenting part. The patient is given 9.5 cubic centimeters of infundin immediately after the delivery of the child and the bladder is then emptied. Within 5 minutes, usually after the second contraction, the uterus is drawn high up in the abdomen and with the extended thumb across the front of the uterus and the fingers behind it, the walls are compressed and the placenta expelled. This method has been the author's practice for 5 years in common with other associates and it has fewer retentions and fewer postpartum hemorrhages and the average blood loss has been greatly reduced.

The dressings, if soiled, are now changed and a towel spread across the anal orifice with clamps to

adjacent dressings to protect suture and other materials. An écarteur is now introduced to expose the raw surfaces, and with a curved non-cutting needle and continuous No. 1 iodine catgut the rectovaginal septum is restored by beginning at the vertex of the raw surfaces. This is done by entering the raw surface just underneath the vaginal mucosa and emerging in the midline, entering again at the midline on the opposite side and emerging just under the cut edge of the vaginal mucosa. These sutures are continued down until the region of the hymen is reached. The suture is not tied at present. Another continuous suture is now used to close the vaginal mucosa down to the hymen or just outside of it. Three interrupted sutures are now used to build up the perineum. The first, the crown suture, enters just below the cut hymen, goes out widely laterally under the perineal skin and emerges in the midline again to penetrate laterally widely and emerge at the opposite hymenal edge. The 2 others are inserted similarly at half inch intervals down the perineal raw surfaces. They are all placed fan like with the vertex toward the vaginal septum. The continuous septal suture is now tied, then the vaginal suture and lastly the three perineal sutures. If these latter undermine the perineal skin properly the perineal margins will fall together completely juxtaposed. These margins may be fixed with interrupted No. 1 catgut or by a continuous subcutaneous stitch. All sutures should be tied without tension. The vagina is now washed out with green soap, perineal sutures dried and the operation is completed. In every case so treated an episiotomy was always necessary at another delivery and in not one of the cases so treated has there been any prolapse. In second or subsequent repairs at delivery it is customary to extend the raw surface by excising a half inch of vaginal mucosa from the hymen to the apex of the vaginal incision, and then suturing as described above. A word of caution is here necessary. Oftentimes the retraction of the muscularis of the rectovaginal septum causes the vaginal mucosa of the episiotomy to roll inward thereby reducing very considerably the thickness of the rectovaginal septum. This can easily be unmasked by rolling the cut margin of the vagina outward and undermining it with the first layer of suture.

The great advantage of this method is its painlessness in the majority of instances. If pain occurs it is due to one of three causes, either to the inclusion of the rectal nerves with the suture, or to constriction of the tissue by too great tension, or to oedema, which is due to lymphatic obstruction.

There are three types of cases that do not heal well with the above treatment. They are those in which the head has been allowed to rest too long on the pelvic floor and severely toxic cases, and lastly those cases of prolonged dystocia, which are infected before labor is completed.

When multiparae come under observation for delivery with a vaginal floor that has suffered great damage in previous confinements, with quite a marked degree of cystocele, it is the author's policy to adopt the same management as in the case that comes for the first delivery. The perineum is incised in the usual way and an extensive denudation and perineorrhaphy are performed. One hesitates to state the following, that most of the cases of cystocele by being supported by a strongly repaired perineum undergo a very marked amelioration during the involution of the puerperium. One hesitates to make that statement but both the author's first assistant and the author himself came to the same conclusions independently after years of observation of cases so treated, and these independent observations were not expressed to each other until quite recently.

But probably the greatest advantage of early intervention in labor is found in the greatly lowered percentage of fetal mortality. It is noteworthy that the great majority of deadborn children succumb during the second stage of labor. The reasons for that are not hard to find. First, when the head has distended the pelvic floor the uterine force has gathered strength by virtue of the great retraction of the upper uterine segment, accentuated by three contributing factors, by the rupture of the bag of waters, thereby reducing the uterine content by the descent of the child causing a further reduction in uterine content, and by the stretching of the lower uterine segment and vagina causing a still further retraction of the upper segment. To every fraction of uterine retraction the placenta has to accommodate itself so that its circulation becomes slowly impeded. Added to this there is the tendency for uterine contraction (spasm) of a fatigued uterus to supervene, causing asphyxia of the child and lastly we must consider the growing frequency of the pains and the shorter intervals of relief in which the child develops a condition of cumulative asphyxia, in which each pain adds a small cumulative fraction to a progressive asphyxia. A fetus's blood aeration at best is only 70 per cent of the normal. These are all obviated by a prophylactic intervention, and during the last 10 years of active conservative obstetrics the author's fetal mortality during labor has been reduced to one-quarter of

the figure obtained by the policy of masterful inactivity.

If brilliant results have followed the use of forceps in experienced hands in vertex presentations, these fade almost into insignificance compared with the results obtained in breech cases. The effects that follow forceps in breech are so astounding and so logical that one is tempted to state that in cases that present any difficulty in the delivery of the aftercoming head the lack of the use of forceps is a culpable neglect. With the forceps, the aftercoming head is under control at all time, there is none of the deadly traction upon the neck, there is no forcible elevation of the tentorium and the perineum is kept away from the child's mouth by the forceps so it can breathe while slow delivery is practiced. In several instances by such methods difficult deliveries have occupied up to 15 minutes with the child not in the least distressed. With an assistant holding the child at right angles to the plane of the table and not farther the operator's hands are free for his work. The application is usually tolerably easy. Any forceps will do, but Piper's forceps for the aftercoming head are a great comfort, owing to the ease of their application, and the bending back of the shanks leaves the field of the child's mouth free for cleansing and aeration. The high death rate of both breech and version and extraction cases is in most instances attributable to tentorial tears and cervical fractures—both preventable accidents, by refraining from pulling from over extension of the child's head from too great haste and by substituting for these lethal methods a forceps delivery that is as scientific as it is humane.

A last paragraph upon the mortality following forceps delivery. Much of the fetal death rate attributed to forceps is attributable directly to the delay in the use of the instruments. One need but recall that in most instances forceps are used only as a *dernier ressort* when the uterus has exhausted itself and it is well known from the foregoing that it is when the child's head is on the perineum that the greatest number of fetal deaths take place from asphyxia. In many instances neither the distress nor the death is detected before delivery and the result is attributed to the last remedial measure the forceps. In other instances the distressed child suffers the brain lesion before remedial measures are invoked and its death after labor or its distress after labor owing to a cerebral hæmorrhage is always attributed to the instruments. The author's fetal mortality has been reduced 75 per cent since the inauguration of a policy which is conservative of the fetus and mother.

#### CONCLUSIONS

With experienced hands and mature judgment prophylactic intervention in the second stage and suturing causes

- 1 Reduction in the amount of damage to the abdominal wall,
- 2 Minimal damage to the supports of the uterus and bladder
- 3 A completely restored pelvic floor
- 4 Restoration ad integrum of previous obstetrical damage,
- 5 Tremendous reduction in the number of still-borns.

## PYOGENIC SEPSIS

A SURVEY OF 150 CASES<sup>1</sup>

HAROLD NEUHOF, M.D. ARTHUR H. AUFSES, M.D. NEW YORK CITY AND SAMUEL HIRSHFELD, M.D. LOS ANGELES, CALIFORNIA

FOR many years only passing consideration has been given to the clinical manifestations of pyogenic sepsis, apparently because its bacteriological aspects have proved to be of such absorbing interest and moment. The literature is replete with contributions to the bacteriology and pathology of the subject but is lacking in critical studies of symptoms or clinical diagnosis. Surgical methods of treatment have been relegated to the background, with the exception of operative treatment in some special fields. The present day viewpoint can be fairly stated as one of quite complete dependence on the blood culture for the diagnosis, prognosis, and indications for treatment. A study of many cases has led us to conclude that there are fallacies in commonly held criteria on which the diagnosis and treatment of pyogenic (surgical) sepsis are based. It is our opinion that closer attention to clinical manifestations and less slavish reliance on blood culture and other laboratory data would often lead to earlier diagnosis and to the institution of appropriate measures that should appreciably lower the present terrific mortality of sepsis. The subject, of immediate concern in every field of medicine, is much too large to be considered in all its aspects. We shall discuss only certain features of the clinical manifestations, diagnostic considerations, and the treatment of some of the suppurative lesions. The existence of sepsis is evident enough in many cases and a plan of treatment can often be readily formulated. There are numerous instances, however, that call for fineness in the diagnosis of the nature and of the site of the feeding infective focus. Saving of life is perhaps more dependent on carefully considered judgment in this than in any other branch of medicine. Special consideration should be given to what may be termed the preseptic and to the early septic phases of infections because it is in this period that the best results of treatment can be anticipated. Correct surgical treatment depends largely on correct diagnosis and on an understanding of the nature of the pathological process. Surgical procedures will be only generally considered in this paper and details of operative technique will be omitted.

By pyogenic or surgical sepsis, or surgical septicæmia, we mean the clinical septic state in which pyogenic organisms can be cultured from the

blood stream in most cases or in which metastatic foci prove that such organisms recently invaded the blood stream. The primary source of the sepsis is an infected area or a frankly suppurative process. When the original site of entry of the infection has healed, the secondary focus supplying the organisms to the blood stream is suppurative. Viewed in this light the qualifying term "cryptogenic" applied to sepsis can mean only an inability to locate the feeding focus and not the absence of such a focus. The term is, therefore, misleading and should not be employed. Another generally employed term is "bacteriemia," which is synonymous with sepsis for many writers. It is a good term in the laboratory but a poor one at the bedside, for patients presenting transient bacteriemia are not necessarily septic and, conversely, patients obviously suffering from sepsis may have negative blood cultures as will be indicated directly.

The material on which this study is based is a series of 150 consecutive cases with positive blood cultures observed at the Mount Sinai Hospital in 5 successive years. It was gathered from clinical records and an examination of blood culture and autopsy records. During the course of the investigation there were encountered 12 instances in which the diagnosis of pyogenic sepsis could properly be made on clinical grounds but in which blood cultures were negative. Ten of these patients recovered. There was also a group of 11 cases in which blood cultures were negative but in which the evidence at autopsy was clearly indicative of the existence of pyogenic sepsis during life. In only a few of the cases in these groups were many blood cultures taken. In other instances insufficient amounts of blood were withdrawn, cultures were not taken at the time of optimal expectation of positive result, or anaerobic media were not employed. There were also some instances of pyelophlebitis in these groups; the rarity of positive blood cultures in portal vein phlebitis is well known. For statistical purposes the cases in which blood cultures were negative will be omitted from the tabulations referred to in this paper.<sup>2</sup> Their significance, however, should be stressed. No one can deny the occurrence of a

<sup>1</sup>The tables at the end of the paper will be found to classify the cases rather arbitrarily into workable groups based as far as possible on the main primary suppurative lesion.

positive blood culture in the vast majority of cases of pyogenic sepsis at some stage of the infection. Nor can one doubt the likelihood of greater frequency of positive cultures as more and more of the laboratory requirements are met. On the other hand these groups of cases with negative blood culture, observed in ordinary hospital practice, emphasize the necessity of clinical consideration of the patient with appropriate action based on such consideration. The present viewpoint of many clinicians is to withhold action that would have been taken at a given time until or if a blood culture proves to be positive. Such a viewpoint is of course justified in some or many cases. To apply it to all cases, however, can only mean an unwarranted reliance on the laboratory, a lack of appreciation of the significance of negative blood cultures, and in some instances the postponement of appropriate action until too late to save the patient.

Statistical data with accompanying comments will be based on the series of 150 cases but remarks on clinical manifestations and treatment will be based on personal experiences among cases in this series.

#### HISTORY AND PHYSICAL EXAMINATION

Before proceeding with the presentation of some of the clinical manifestations and diagnostic criteria of pyogenic sepsis, a brief consideration of certain features in the history and physical examination is warranted. The patients are usually profoundly prostrated and an accurate history may be difficult to elicit, yet a careful history is of great importance. A special effort should be made to learn if a portal of entry of infection exists. A paronychia, an insignificant infected blister, a sore throat may be the sources of the severest forms of septic invasion. Inquiry should be made concerning the reaction of the patient to previous infections. The interval of time between the assumed primary lesion and a secondary suppurative focus is usually a few days, but may be a week or longer. A persisting infective lesion noted on examination, whether obvious or minute and insignificant, is not to be disregarded. The discovery of a healing or healed wound in a careful physical examination may recall to the patient or to others a lesion that had been completely forgotten. Pain in various localities described by the patient should not be ignored for it may prove a lead to the situation of metastatic foci appearing during later stages although not evident at the first examination. Attention should be given to a history of joint pains or swellings. It will be shown that chills do not regularly attend the

septic course. They are, however, the most significant single feature of the history and true rigors should therefore be differentiated from chilliness or so called nervous chills.

The general physical examination is always to be painstakingly done regardless of an obvious focus of suppuration. Only then may minor additional lesions be found that can completely alter an apparently obvious plan of treatment as well as the prognosis. Tenderness to pressure in a co-operative patient is a valuable find when elicited in the examination of parts at a distance from an assumed solitary focus of suppuration. Areas of tenderness may be the sole signs of the existence of additional foci. Abdominal pain and tenderness may point to a metastatic peritoneal focus. Many illustrative instances can be cited to prove the value of a thorough general examination, but enough has been indicated to show that the examination should never be cursory even when an evident suppurative lesion requiring prompt surgical treatment is present.

The general appearance of a patient suffering from a suppurative septic focus ranges from the flush that goes with any febrile reaction to the ashen pallor and cyanosis of the profound septic state. In general the more severe the sepsis the less evident is the suppurative focus. Therefore the closest scrutiny is required in patients who are profoundly ill with manifestations suggesting the possibility of a suppurative lesion. Pressure tenderness often means little in these gravely ill individuals (and in young children). Careful inspection is often of value for example a slight expansion of a calf when compared with its fellow may be the single objective indication of an osteomyelitis of the tibia. Fullness of the apex of the axilla may indicate a subpectoral phlegmon lying against the axillary structures. Slight swelling of a joint may be the beginning of a severe suppurative arthritis. A rigid neck with the picture of meningeal irritation may be recognized as due to a local suppurative process if fullness of contours is noted on inspection. In short inspection is the most important form of examination in cases of severe sepsis.

The clinical manifestations of sepsis are potent but only a few are of constant or almost constant occurrence. These are generalized pains referable (apparently) to the musculature, fever, enlarged spleen and some form of cerebral disturbance. Such symptoms and signs are evidently not characteristic of sepsis but no other manifestations may be present. The symptoms and signs that are distinguishing features will now be discussed.



TABLE I.—ORIGIN OF SEPSIS

	Cases	Mortality per cent
Osteomyelitis and (or) suppurative joint infections	16	25
Mastoiditis, lateral sinus or jugular bulb thrombosis	19	9.5
Abscesses or carbuncles	23	12.6
Infections (no frank pus)	5	
Postoperative		7.1
Liver and gall bladder suppuration		6
Pneumonia	4	
Miscellaneous (Drug abscess, pericarditis, empyema, post-traumatic P. abscess, etc.)		
Pharyngitis, pyelitis, traumatic phlebitis		
Unicystic abscess, etc.	7	3
Total	90	

TABLE II.—MORTALITY IN RELATION TO CHILLS

	Cases	Mortality per cent
No chills	26	63
One chill	27	77
Two or three chills		
Recurrent chills (more than three)	29	66

Combined mortality of cases with chills, 72 per cent

## SYMPTOMS AND SIGNS

**Chills** In sepsis, chills are probably absolute evidence of invasion of the blood stream by bacteria. They are the most characteristic clinical feature. It is commonly assumed that chills occur in the vast majority of cases of pyrogenic sepsis. This is not true, however for they were present in less than half of our series of cases. Another general impression is that the mortality is lower in the absence of chills. The fact is that the difference is not great enough to warrant any emphasis on prognosis on this basis (Table II). Repeated chills comprise the textbook picture of sepsis yet a solitary chill occurred in 38.5 per cent of 70 patients who had chills (Table III). An interesting feature is the difference in incidence of chills in the different groups of cases; they occurred in almost all the cases of liver and postpartum sepsis whereas they were present in only a third of the carbuncle and osteomyelitis groups, they existed and were usually recurrent in more than half the cases of proved phlebitis. A fact contrary to a generally held view is that chills appeared in less than half (43 per cent) of the cases of proved complicating endocarditis.

**Fever** Another textbook feature of sepsis is spiking temperature. This was not present, however in much more than a third of our cases. Sustained fever with small remissions occurred almost as frequently. Of more significance is the fact that the mortality was higher in our cases of sustained fever (Table IV). In this connection it is interesting to note that spiking temperature was much more frequent in the *Streptococcus hemolyticus* than in the *Staphylococcus aureus* cases in our series. There were a few instances among our

TABLE III.—CHILLS THEIR INCIDENCE IN VARIOUS SEPTIC CONDITIONS

	Cases	Per cent
Occurred in chill	79	88
in 3 chills	27	
in 2 chills	24	
in 1 chill	29	
Recurrent (more than 3)		
in cases with acute endocarditis	43	
in lateral sinus thrombosis cases	15	
in proved phlebitis (including lateral sinus)	21	
in osteomyelitis or joint infections	23	
in abscesses or carbuncles	22	
in infectious pt.	26	
in liver cases	29	
in postoperative septic cases	45	
in postpartum cases	100	
in miscellaneous cases	43	

TABLE IV.—MORTALITY IN RELATION TO TYPE OF FEVER

	Cases	Mortality per cent
Low		30
Irregular		25
Sustained		76
Spiking	13	63

cases in which fever was low throughout the clinical course and complete absence of fever in cases of sepsis has been described.

**Bacteria found in blood cultures in relation to types of lesions.** The *Streptococcus hemolyticus* and the *Staphylococcus aureus* (in the blood stream) accounted for fully three-fourths of all the cases, the former being somewhat more commonly encountered (Table V). The incidence of these as well as of other pyrogenic organisms differed greatly however in the different types of lesions. The larger groups of cases present some striking figures. Thus the *Staphylococcus aureus* was the causative agent in 75 per cent and the *Streptococcus hemolyticus* in 20 per cent of the cases of bone and joint infections (Table VI). On the other hand the hemolytic streptococcus was present in 86 per cent of the cases of mastoiditis and sinus and jugular bulb thrombosis, whereas the *Staphylococcus aureus* was not encountered in a single instance in this group. Sepsis due to frank abscess formation or to carbuncle was characterized by a far higher incidence of staphylococcus than of streptococcus whereas the reverse was true of sepsis derived from infections that were diffuse and not frankly suppurative. The organisms commonly found in the blood stream in the gall-bladder and liver group of cases were the anhemolytic streptococcus, bacilli of the Friedländer group and the *Bacillus coli* the hemolytic streptococcus was an occasional organism, but the staphylococcus was not encountered. The anaerobic streptococcus plays an important rôle in postpartum sepsis. It is clear therefore, that there is often a definite relationship between

TABLE V.—BACTERIA CAUSING SEPSIS AND THEIR INCIDENCE

	Cases	Incidence per cent
<i>Streptococcus hemolyticus</i>	64	43
<i>Staphylococcus aureus</i>	57	34
<i>Streptococcus anhemolyticus</i>	10	7
<i>Bacillus coli</i>	5	3
<i>Streptococcus anserobius</i>	4	3
<i>Streptococcus albus</i>	3	
Gram positive cocci	3	
<i>Bacillus of Friedländer group</i>	3	
<i>Pseudomonas Type I</i>		
<i>Bacillus pyocyaneus</i>		
<i>Staphylococcus hemolyticus albus</i>	1	
Infection		
<i>Pseudomonas type IV</i>		
<i>Streptococcus</i> and <i>staphylococcus</i>		
Total	50	

TABLE VI.—RELATION OF TYPE OF ORGANISM TO TYPE OF LESION

	Per cent
Osteomyelitis and (or) sequestrative joint infection, 30 cases	
<i>Staphylococcus aureus</i>	75
<i>Streptococcus hemolyticus</i>	20
<i>Streptococcus anserobius</i>	2.5
A gram positive cocci lost on transplant	2.5
Mastoiditis, lateral sinus thrombosis and petrosal jugular bulb thrombosis, 50 cases	
<i>Streptococcus hemolyticus</i>	86
<i>Pseudomonas Type I</i>	7
<i>Streptococcus anserobius</i>	3.5
<i>Bacillus pyocyaneus</i>	3.5
Abscesses or carbuncles, 30 cases	
<i>Staphylococcus aureus</i>	60
<i>Streptococcus hemolyticus</i>	
<i>Staphylococcus albus</i>	7
<i>Streptococcus anhemolyticus</i>	4
<i>Bacillus coli</i>	4
A gram positive cocci lost on transplant	4
Infections with no break pus, 5 cases	
<i>Streptococcus hemolyticus</i>	66
<i>Staphylococcus aureus</i>	20
<i>Staphylococcus albus hemolyticus</i>	7
<i>Streptococcus anserobius hemolyticus</i>	7
Postoperative sepsis, 11 cases	
<i>Streptococcus hemolyticus</i>	63
<i>Streptococcus anhemolyticus</i>	10
<i>Staphylococcus albus</i>	9
A gram positive cocci lost on transplant	9
Liver and gall bladder sepsis, cases	
<i>Streptococcus anhemolyticus</i>	40
<i>Bacillus of Friedländer group</i>	30
<i>Bacillus coli</i>	20
<i>Streptococcus hemolyticus</i>	10

the organism and the type of lesion from which a sepsis is derived. This relationship may be of decisive value in the diagnosis of obscure cases in which physical examination does not clearly disclose the origin of the sepsis.

#### MORTALITY

*Mortality in relation to types of lesions and to bacteria* The mortality in the 150 cases of this series was 67 per cent. It was lowest in the sinus thrombosis group (38 per cent) and highest in the liver gall bladder and postpartum groups (Table VII) In view of the present day tendency toward conservatism in the treatment of acute osteo-

TABLE VII.—MORTALITY IN RELATION TO LESION

	Per cent
Osteomyelitis and (or) joint infection	58
Lateral sinus thrombosis, etc.	38
Abscess or carbuncle	75
Infection without pus	66
Liver and gall bladder sepsis	100
Postoperative sepsis	75
Postpartum sepsis	100
Miscellaneous cases	9

TABLE VIII.—MORTALITY IN RELATION TO ORGANISMS

	Per cent
<i>Staphylococcus aureus</i>	68
<i>Streptococcus hemolyticus</i>	59

TABLE IX.—MORTALITY IN RELATION TO LESION AND ITS ORGANISM

	Cases	Mortality per cent
Osteomyelitis and (or) joint infection		
<i>Staphylococcus aureus</i>	27	55
<i>Streptococcus hemolyticus</i>	7	85
Lateral sinus thrombosis		
<i>Streptococcus hemolyticus</i>	5	36
Abscess or carbuncle		
<i>Staphylococcus aureus</i>	7	8
<i>Streptococcus hemolyticus</i>	6	66

TABLE X.—MORTALITY IN RELATION TO THE NUMBER OF COLONIES IN THE BLOOD CULTURE

	Cases	Mortality per cent
1 to 5 colonies	26	57
6 to 5 colonies	2	50
25 to 100 colonies	17	30
50 to 200 colonies	2	85
Over 200 colonies	1	85
Colonies too numerous to count	1	86
No count of colonies	43	

myelitis and joint infections the high mortality of 58 per cent in this group should be carefully noted.

The prognosis of streptococcus sepsis is commonly thought to be worse than that of staphylococcus sepsis. In our series the mortality was higher in the latter (Table VIII). This may be referable to the inclusion of a large number of sinus thrombosis cases nearly all due to a streptococcus infection and with relatively low mortality. Omitting these cases the mortality is about the same. There are striking contrasts, however, in some of the groups of cases. The most important are the osteomyelitis group in which the mortality is much greater when the hemolytic streptococcus is the causative agent, and the abscess and carbuncle group in which sepsis from the *Staphylococcus aureus* has the higher mortality (Table IX).

*Mortality in relation to the number of colonies in the blood culture* The mortality was almost pre-

TABLE XI.—MORTALITY IN RELATION TO AGE

Years	Mortality per cent	
	Cases	Deaths
Under 10	10	10
10 to 19	20	20
20 to 29	18	26
30 to 39	1	50
40 to 49	6	85
50 to 59		88
Over 60	5	87

TABLE XII.—THE ORGANISMS IN ACUTE VEGETATIVE ENDOCARDITIS

	Cases
<i>Streptococcus hominis</i> Lewis	4
<i>Staphylococcus aureus</i>	6
<i>Streptococcus hemolyticus</i> and <i>Staphylococcus aureus</i>	
<i>Pseudomonas</i> (2) (p. 1)	

cisely the same whether there were 1 to 5, 5 to 25 or 25 to 100 colonies per cubic centimeter in the blood culture (Table X). It rose when the count was over 100 but was not much higher even when the colonies were too numerous to count. These data cast grave doubt on the widely held view that the prognosis of sepsis can be based on the number of colonies in the blood culture. There is little more justification for assuming a hopeless attitude because of a richly positive blood culture than there is for making a good prognosis merely because the culture reveals few organisms. The clinical condition and the possibility of eradicating the feeding focus are far better guides as to the prognosis.

#### COMPLICATIONS AND METASTATIC FOCI

*Acute endocarditis.* Much has been written about this complication of septic infection and the subject is, of course, of great clinical significance. The analysis of our cases leads us to conclude that the correct diagnosis can only rarely be made with certainty and that the assumption of the existence of endocarditis should therefore not interfere with any well conceived plan for the eradication of the feeding septic focus. A number of significant data were derived from the study of the 150 cases. In the first place vegetative endocarditis was found in only 14 cases, that is in less than 10 per cent of the series. In only 5 of these patients was it suspected during life. There were a number of instances in which the diagnosis was made with varying degrees of positiveness on the basis of increasing adventitious cardiac sounds and increasing numbers of colonies in the blood culture and in which autopsy failed to reveal the lesion. In the second place some observers believe that endocarditis is most likely to develop at the site of an old lesion. Chronic valvular disease was found in only 4 of our 14 cases, slight thick-

TABLE XIII.—NUMBER OF COLONIES IN BLOOD CULTURES IN CASES WITH ACUTE ENDOCARDITIS

	Cases
Under 8 colonies	5
90 colonies	
Too numerous to count	1
Unstated number	5

TABLE XIV.—TYPE OF LESION IN WHICH COMPLICATING ACUTE ENDOCARDITIS OCCURRED

	Cases
Abscess of cutaneous	4
Mastoid or lateral sinus thrombosis	
Osteomyelitis and (or) joint infection	
Postoperative (hemorrhagic) sepsis	
Postpartum sepsis	
Prostatic phlebitis	
Erysipelas	
Pericarditis	
Infection of toe (see Frank post)	
Otitis	

ing of valves was noted in 2 cases, and mild atherosclerosis in 1. In the third place the *Staphylococcus aureus* and the hemolytic streptococcus were about equally responsible for the endocardial lesions (Table XII). Fourth, the commonly held opinion that the existence of endocarditis can be postulated because of progressive increase in the number of colonies or because of richly positive cultures is not supported in our series (Table XIII). There were 5 cases in which the maximum number of colonies at any time was under 18. In the fifth place, chills, petechiae, or pustules did not characterize the clinical course in our proved cases of endocarditis. These phenomena, assumed by some to be constant and characteristic, occurred in only 6 of the cases. A final point, of great clinical significance in our opinion, is the fact that vegetative endocarditis occurred only once in the largest group of cases, the bone and joint infections (Table XIV). All these data call for a revision of commonly held views which lead to an unwarranted fatal prognosis based on supposedly positive evidence of vegetative endocarditis.

*Acute phlebitis and its treatment.* The discussion of the clinical and bacteriological manifestations of pyogenic sepsis leads to a consideration of the most important focus from which it is derived. According to some observers an infective (usually suppurative) phlebitis is the common if not the invariable source of septic invasion. The lesion may be minute and discoverable only after microscopic search through blocks of infected tissue. The rôle it plays under such circumstances is of interest to the student of pathology but is as yet of little moment to the clinician. Of vital clinical importance on the other hand is a phlebitis of one of the larger veins due to extension of infection

TABLE XV—BACTERIA IN SEPSIS WITH PROVED PHLEBITIS

	Cases
<i>Streptococcus hemolyticus</i>	1
<i>Streptococcus anihemolyticus</i>	7
<i>Staphylococcus aureus</i>	6
<i>Bacillus coli</i>	3
<i>Bacillus</i> cf. <i>Friedländer</i> group	
<i>Streptococcus anserinus</i>	
<i>Staphylococcus albus</i>	
A group positive cocci lost on transplant	
<i>Staphylococcus aureus</i> and <i>Streptococcus hemolyticus</i>	

from the original lesion or from a neighboring suppurative focus. The source of the phlebitis can then be relegated to a secondary position because the involvement of the vein becomes the significant lesion to be controlled if the sepsis is to be combated.

The mortality that accompanies the tardy recognition of suppurative phlebitis as the cause of sepsis is as well known as the mortality that accompanies inadequate treatment. Whereas the clinical picture of phlebitis of the lateral sinus and of the pelvic veins is generally recognized phlebitis derived from suppuration in more or less superficial soft parts is of equal importance and is not as well known. The clinical picture is usually clean cut. There is the history of the distant source of infection often an insignificant lesion such as a blister of a finger. The lymph nodes in the region of the infected vein are often involved in a suppurative process. There is frequently a prolonged chill at an early stage whose repetition does not have to be awaited in order to appreciate its significance. If a blood culture is taken it will often prove to be positive in a few hours. A collection of pus in the soft parts about a vein no matter how large, does not suffice to explain this picture. In our opinion one must assume the existence of a phlebitis and usually a suppurative thrombophlebitis in the main regional vein—brachial axillary subclavian femoral, iliac, internal jugular. A small thrombosed vein in the suppurative area does not adequately fulfill the requirements. The lesion is characteristically a whitish, thickened and inflamed vein visibly and palpably expanded by its contained suppurative thrombus. Brief reference can be made to exceptional forms of vein involvement. One type is a periphlebitis associated with an obliterative but non suppurative endophlebitis in which abscesses, perhaps only pinpoint in size lie in inflammatory tissue encircling the vein. The blood culture may be negative under such circumstances despite repeated chills. Another variety is an extensive or gamizing periphlebitis and endophlebitis with surrounding inflammatory tissue but no pus. A form of phlebitis characterized by slight changes in the

TABLE XVI—NUMBER OF COLONIES IN BLOOD CULTURES IN CASES WITH PHLEBITIS

	Cases
to 1 colonies	11
Over 10 colonies	9
Unstated number	13

TABLE XVII—THE ORGANISMS IN CASES WITH PERIPHERAL METASTATIC FOCI

	Cases
<i>Streptococcus hemolyticus</i>	30
<i>Staphylococcus aureus</i>	5
Miscellaneous organisms	9

wall of a blood containing vein is occasionally observed.

Excluding the 19 lateral sinus cases, a phlebitis as the immediate cause of the sepsis was demonstrable in 33 of our cases. In only 8, however, was it disclosed at, and treated by operation. The reason is perhaps to be sought for in a generally held view that the symptomatology of phlebitis as the cause of sepsis must be classical. The most important point we wish to make in this connection is that chills occurred in only 21 of the 33 cases of proved phlebitis (63 per cent) and that they were present in a still smaller proportion (55 per cent) of the lateral sinus cases (Table III). It is of interest to note that the streptococcus either hemolytic or anhemolytic, is the most common invader in cases of phlebitis whether of the lateral sinus or of the other veins, but that the hemolytic streptococcus is almost the sole cause (86 per cent) of phlebitis of the lateral sinus (Tables VI and XV). A phlebitis is not necessarily characterized by large numbers of colonies in the blood culture. Of the 33 cases the number of colonies was under 10 in 11 cases (Table XVI).

The treatment of a phlebitis from which sepsis is derived is the eradication of the focus whenever feasible. The otological surgeon working in a cramped space and on a structure which he cannot excise has nevertheless set up a standard of results which is far better than that attained in other fields more susceptible of radical attack. Ligation of the vein proximally to the site of phlebitis is obviously of little value if there are parallel branches for there is left behind a lesion which will invade the branches of the vein and thereby continue to infect the circulation. Excision of the infected vein to limits that appear normal to the naked eye should be practiced whenever possible. That involved vein may be left behind under such circumstances cannot be questioned. The results in lateral sinus phlebitis demonstrate however, that recovery can follow if only the major part of the infective lesion is eradicated. Technical

TABLE XVIII.—THE ORGANISMS IN CASES WITH MULTIPLE LUNG ABSCESSSES

	Cases
<i>Staphylococcus aureus</i>	20
<i>Streptococcus hemolyticus</i>	0
<i>Streptococcus subvirescens</i>	5
<i>Streptococcus anserinus</i>	
<i>Bacillus coli</i>	
<i>Bacillus of Friedländer group</i>	
<i>Streptococcus albus</i>	
A gram positive coccus lost on transplant	

TABLE XIX.—THE NUMBER OF COLONIES IN BLOOD CULTURES OF CASES WITH MULTIPLE LUNG ABSCESSSES

	Cases
to 25 colonies	7
25 to 50 colonies	4
Over 50 colonies	14
Unstained	7

features and the results of radical treatment are considered elsewhere.<sup>1</sup>

*Suppurative (and metastatic) foci and their treatment.* Metastatic foci may of course, occur anywhere in the body. When on or near the surface they are discernible clinically and may be amenable to treatment. We term these surface lesions peripheral metastatic foci and have included under this heading subcutaneous abscesses, pustules, bone and joint lesions, etc. The metastatic lesions occurring in the internal organs are usually not recognizable clinically with the exception of multiple lung and kidney abscesses and metastatic peritonitis.

Our analysis shows that cases with more numerous peripheral metastatic foci have an appreciably lower mortality than those with one or two such lesions (Table XX). This may be an indication that the appearance of multiple peripheral foci is an index of lower mortality, or may merely be referable to a sufficiently prolonged survival for the appearance of such foci. In any event the recognition and management of peripheral foci are of clinical importance because the chances for survival are greater in patients presenting multiple lesions.

The general features of the peripheral foci can be briefly stated. They occurred in almost half of the cases in our series (43 per cent). The total mortality in patients with such foci was somewhat lower than in those in which none appeared (62 per cent as compared with 71 per cent). Chills occurred with the same frequency in patients with and without metastatic lesions. A fact contrary to a general impression is that the hemolytic

TABLE XX.—MORTALITY IN RELATION TO NUMBER OF PERIPHERAL METASTATIC FOCI

	Cases	Mortality per cent
1 focus	31	41
2 foci	19	71
3 foci	9	77
4 or 5 foci	4	75

streptococcus is at least as commonly the causative organism of a peripheral metastatic focus as the *Staphylococcus aureus* (Table XVII). This is in striking contrast to the incidence of these bacteria in multiple abscesses of the lungs (Table XVIII).

The local manifestations of the septic suppurative focus vary within such wide limits that an all inclusive description is not feasible. The area of the infection is generally found to be far more extensive than would be anticipated from the physical signs. Localized tenderness is only a valuable sign in a co-operative patient. Increased heat is usually present even over a deeply situated lesion. Obvious, fluctuant swellings are generally associated with the less severe infections. Sometimes solely indirect evidence points to the most significant factor in a suppurative focus. To cite a familiar example, suppurative phlebitis of the saphenous or femoral vein or of both can be assumed to exist in a case of acute femoral adenitis associated with chills and positive blood culture, even though the involved vein cannot be felt. A difference that has been noted between the usual aerobic infections and those due to anaerobic organisms may be mentioned. An anaerobic infection derived from a distant portal of entry is characterized by a less typical septic course, the lesion is apt to be more indolent and more variable in appearance as it is observed from time to time and there is often an erysipelas-like invasion of the overlying skin when the lesion is situated in the soft parts.

#### REGIONS AFFECTED

In proceeding now to take up some of the regions in which suppurative foci appear we shall assume that they may be solitary or that two or more regions may be simultaneously or successively involved. The remarks to be made under each heading will be based on personal experience and will not be an attempt to deal fully with these subjects.

*Subcutaneous tissues.* Subcutaneous phlegmons associated with widespread necrosis occur more commonly over the lateral chest wall than in other regions, in our experience, and the resemblance to erysipelas may be so close that the differentiation cannot be made with any assurance. The involve-

<sup>1</sup>*Medical Herald.* The diagnosis and operative control of acute pyogenic phlegmons complicated by general septic stream. Ann Surg 1933, June.

ment of the skin is not so characteristic, the sharp line of demarcation is not as evident, the skin spread is not as rapid, the initial chill may be wanting and there is no local source of infection. These characteristics exist, however, in some instances of erysipelas. In one case a number of competent observers agreed on the diagnosis of erysipelas the case proved to be one of pyogenic sepsis and at operation an extensive phlegmon of the chest wall was found to be the feeding focus.

**Bones and joints** Suppurative foci in bones and joints have been the subject of a vast literature on diagnosis and methods of treatment. We shall not venture any general discussion of the topic, but shall present briefly a point of view. An acute osteomyelitis of one of the long bones derived from some distant portal of entry is of course, a metastatic focus. At the outset it is the sole focus in the majority of cases. Without prompt surgical treatment progressively septic manifestations may occur. Osteomyelitis of flat bones does not usually pursue a fulminating course and localization can frequently be awaited. Early recognition of an osteomyelitic focus is the essence of the situation. Minor evidence of bone involvement should suffice for the diagnosis of an osteomyelitis, especially when a widespread invasion of bone appears to exist. To await extensive expansion and edema of a limb on the one hand, or a positive blood culture in the presence of relatively slight but definite signs on the other hand, may mean the difference between a simple surgical problem and one that cannot be solved by any means at our command. There is a strong trend toward conservatism at the present time both in the indications for and the operative treatment of acute osteomyelitis. Intelligent conservatism is commendable. But it is a far cry from this to the exhibition of a set plan for non-operative or limited operative treatment which is pursued regardless of the clinical developments in a case. In our opinion, the treatment of acute osteomyelitis ranges from intelligent non-operative treatment to intelligent radical surgery depending on the stage at which the lesion is seen and the characteristics of the clinical picture.

When a patient is profoundly ill or septic and the osteomyelitic focus is obviously limited in extent, the situation requires careful management. We have seen a number of instances that involved judgment in operative indication rather than in diagnosis. To illustrate the point, we cite the case of a young boy suffering from an acute osteomyelitis localized to the upper end of a tibia and a very severe septic state. The impression we gained was that the bone focus was

an incidental part of the sepsis and this was supported by the blood culture report of *Staphylococcus aureus* in colonies too numerous to count in the plates. Pulmonary metastatic lesions soon appeared. During the septic state simple incisions were made for the evacuation of the pus in the soft parts around the upper tibia, and the general condition was maintained by intravenous drip which was continued for many days. The diseased area in the bone was operated upon only after recovery from the sepsis. The rather extensive osteotomy as an initial procedure would not have effected a cure and would probably have reduced the chances for recovery.

Acute osteomyelitis of the upper end of the femur presents a separate problem, and usually accompanied by infection of the hip joint, opens the question of the diagnosis and management of suppurative articular and para articular foci. The involvement of a joint may begin in one of several ways. The typical picture is, of course one of a severely inflamed joint, with redness increased heat, effusion great pain, and inhibited function. Less severe invasions are characterized by seropurulent effusions containing relatively fewer organisms, and tending toward spontaneous resolution. In the hip joint particularly we have found that spontaneous subsidence of proved suppurative lesions can occur although destruction of the head and neck of the femur may unfortunately be the residue. A difficult problem may be faced when the manifestations of septic invasion begin with the involvement of many joints, all clearing up but one or two. The lesion in the remaining joint or joints may be deceptively indolent for a number of days so much so that suppuration is not apt to be considered as the cause of the persisting effusion. A joint should be aspirated for diagnosis in all doubtful cases, for progressive destruction of the joint may be going on. Several experiences have convinced us that insidious but progressive spread is particularly prone to occur in the apparently indolent cases. An example was a woman who came under hospital observation with a polyarticular infection probably derived from the throat, and low grade sepsis. All joint manifestations soon subsided with the exception of one knee joint. A slowly increasing effusion with little limitation of function and not much pain was the local picture. The fever was low. After a week fever ranged at a higher level and the effusion in the knee joint did not appear to account fully for the fever and prostration. Finally the knee joint was aspirated and pus was obtained. At operation a widespread suppuration in the joint was found together with extension into the

surrounding bursae and invasion of the fascial planes to mid thigh and mid calf

Spontaneous subsidence of suppurative foci involving joints and of acute osteomyelitis may occur but is surely not to be awaited as the customary outcome. When however the source of septic invasion has been adequately controlled (by excision of a suppurative phlebitis, for example) foci in bones and joints that appear thereafter tend toward subsidence or to circumscribed localization. We have seen suppuration in joints (proved by aspiration) and obvious osteomyelitic lesions subside spontaneously. Whether this is due to an increased resistance of the patient after the source of the invasion of the blood has been eliminated or to lessened bacterial virulence or to some other unknown factor is not germane to this discussion. The fact remains that the lesions may subside without operation or with less extensive operations than those customarily employed and that a conservative attitude may well prove to be correct.

The discussion of suppurative septic foci has been limited to surface lesions up to this point. Turning now to lesions in the depths we shall limit our remarks to certain fields, omitting some systems such as the genito-urinary and the female generative

**Nervous system.** Cerebral manifestations are characteristic of sepsis, as has already been stated. The differentiation between those due to general toxic or septic invasion and those due to a cerebral metastatic focus may be difficult or indeed impossible except by further observation. Symptoms of meningeal irritation may be very severe in the absence of any demonstrable cerebral focus, especially in children. For example, a child with sepsis and a suppurative arthritis of an ankle joint was wildly delirious, with rigid neck and positive Kernig's sign; these manifestations subsided after drainage of the joint and subsidence of the sepsis. The diagnosis of meningitis should be confirmed by spinal tap because the picture of meningitis can be so closely simulated and because the existence of a metastatic meningitis renders futile any operative procedure. The finding of bacteria in the spinal fluid without the cytology of meningeal reaction does not establish the diagnosis of meningitis. We know of an instance of recovery after streptococci were found in the spinal fluid when the suppurative focus near the meninges was eradicated.

The state termed toxic psychosis is not uncommonly encountered in sepsis. The important fact is that it may mask a cerebral metastatic lesion. We have been in error on several occasions in cases

in which evidences of focal cerebral lesions subsequently appeared. Such lesions are usually brain abscesses presumably derived from septic emboli. On the other hand we have noted the spontaneous subsidence of focal manifestations as severe as massive hemiplegia which have developed during the course of a suppurative lesion elsewhere (lungs).

**Lungs and pleura.** The surgical aspects of pulmonary invasion by septic emboli require some consideration. Miliary foci septic infarcts, multiple abscesses are of course part of the picture of advancing pyogenic sepsis. Numerous pulmonary foci may be derived from a single untreated septic lesion notably a thrombophlebitis. Such foci may subside spontaneously after the feeding focus has been eradicated. This observation, surprising though it may appear has been confirmed by the roentgen-ray evidence of the presence and disappearance of metastatic abscesses in the lungs in several cases in our experience. The incidence of proved multiple lung abscesses in sepsis in our series was 28 per cent (Table XVIII). The statistics bring out two other points of interest, first, that the incidence of multiple lung abscesses is not necessarily related to the number of organisms in the blood stream (Table XIX) and, second, that the *Staphylococcus aureus* is by far the most common causative organism (Table XVIII).

The question of the surgical treatment of pulmonary foci as part of a sepsis is, therefore, largely confined to the question of a single or a small number of staphylococcus abscesses. A solitary metastatic focus is by no means unique. The pulmonary manifestations simulate those of an ordinary pneumonic infiltration. The peripheral focus from which the pulmonary lesion is derived may be quite insignificant. Indeed we have seen a number of cases in which there was no demonstrable primary lesion and no history of a pre-existing portal of entry. Death from sepsis may occur while the abscess is still confined to the lung. On the other hand, there is a decided tendency for the staphylococcus lung abscess to extend to and rupture into the pleura. When there has been an opportunity for the formation of adhesions a localized pyopneumothorax or pyothorax is the result. In such instances, the abscess of the lung is usually small and subpleurally situated and the perforation may be minute. Often, however the abscess is of large enough size to invade a bronchus and rupturing into the free pleural cavity gives rise to a tension pyopneumothorax. The mediastinum is shifted to the opposite side and the clinical picture is one of alarming mechanical embarrassment. Prompt recognition of the situa-

tion by physical and roentgenological examination is imperative because the simple institution of closed drainage may suffice to care adequately for the condition as we have noted in a number of instances. Parallel statements hold for the more rarely encountered streptococcus abscesses of the lung.

**Kidneys** Although the subject of renal involvement will not be discussed it should be stated in passing that multiple abscesses of the kidney probably occur as frequently as multiple abscesses of the lungs and that spontaneous recovery from such lesions in the kidneys may take place in the same manner as from similar lesions in the lungs. Not infrequently the picture of the renal lesion is as much in the foreground as that of the Staphylococcus aureus abscess of the lung which was described.

**Pertoneum** Metastatic peritonitis is rather generally pictured as an incidental part of a hopeless septic invasion. In not a few instances, however, the peritonitis is the sole metastasis or one of a small number of metastatic foci. In our experience these are usually cases in which the peritoneal lesion is derived from a streptococcal nasopharyngeal infection and occur most frequently in children. It is not easy to understand why this type of metastatic streptococcus peritonitis, which is far from rare, is not more generally recognized. The condition is of clinical importance because the correct diagnosis leads to an appropriate non-operative therapy which may invite recovery. The diagnosis is usually not difficult if the condition is borne in mind. The patient most often a child, is ill out of proportion to the abdominal signs. Pain in the abdomen is not severe, is not localized, there may be little if any rigidity and tenderness is diffuse. There should be little question as to the diagnosis if there is a co-existing angry red throat and any evidence of an additional metastatic focus. However there are cases in which the picture of an acute appendicitis or other local process is closely simulated. Abdominal puncture should be performed in doubtful instances. We have employed diagnostic abdominal puncture in hundreds of cases have shown that it is free from danger and that definite information can usually be obtained by the procedure. When the purulent fluid that is withdrawn by abdominal puncture contains only streptococci the diagnosis of a metastatic peritonitis is confirmed if already suspected on other grounds. A pure streptococcus peritonitis is very rarely derived from an acute appendicitis. The reason this subject is stressed is that the chances for recovery are reduced if an abdominal operation is unnecessarily performed

for metastatic streptococcus peritonitis in its early stages. In later stages the infection may localize and an intraperitoneal abscess can then be treated by simple drainage. Finally we have shown that metastatic streptococcus peritonitis, proved to exist by abdominal puncture, can clear up spontaneously.<sup>1</sup>

#### REMARKS ON SURGICAL TREATMENT DR. BLOODGOOD

A single thought should be kept in mind in the treatment of a septic suppurative focus, and that is the saving of life. The natural desire to obtain nice cosmetic results, the wish to conserve structures, to save limbs, are all secondary considerations. It is well to repeat that the suppurative lesion is usually much more extensive than the physical examination indicates. The primary principle in the surgical treatment is in our opinion the exposure of the suppurative focus to its full limits. The only exceptions are instances of general septic invasion in which the suppurative focus is interpreted as being an incidental part of the picture. When at all feasible, a focus that is diagnosed as the cause of the clinical picture should be subjected to a vigorous surgical attack for its eradication. The time to operate is when the clinical diagnosis is made and not when it is confirmed by the subsequent course of events. The outcome may depend largely on a willingness to face the situation promptly and wholeheartedly. Spontaneous recovery can occur in rare instances as the result of the recession of the feeding focus or the development of a simple abscess at its site. There is no known method of determining when such a fortunate outcome may take place. It is therefore, far more safe to proceed with the exploration of the site of the suspected feeding focus or with the attempt at eradication of the known feeding focus, particularly when the region is surgically a reasonably accessible one.

The surgical requirement is not a mastery of technique but rather an appreciation of the pathology of the suppurative focus. Standard operative procedures often have to be laid aside to meet the individual situation. Precision of maneuver is necessary but it should be based on a plan to disclose the full extent of the pathological process. A single striking example is given to illustrate our point of view.

The patient who had had a bleb on the left thumb began to have chills and fever and pain in the left chest and shoulder two days later. Chills, and fever ranging to 103 degrees and higher continued for 8 days. On examination there was found a tender swelling in the left axilla made more prominent by abducting the arm, but not very

<sup>1</sup>Neuhof, Harold, and Cohen, Ira. Abdominal puncture in the diagnosis of acute intraperitoneal disease. *Ann. Surg.* 1916 April.



obvious in this stout individual. Foci, interpreted as metastatic, existed in an elbow and in one of the phalanges. A blood culture that had been taken several days before the patient was seen, revealed many colonies of hemolytic streptococci to the cubic centimeter. At operation, performed directly after the patient came under our observation, a very large, multilocular subpectoral abscess was found. It was laid open to its full limits by cutting across both pectoral muscles. Despite the large amount of pus that was encountered, the clinical picture was not adequately accounted for. Accordingly the region of the axillary vein was examined. Inflamed lymph nodes were noted and these led directly to the vein. It lay in the wall of the abscess cavity embedded in inflammatory tissue adherent to the axillary artery. A thrombus 3 inches long, later found to be a suppurating thrombus, could be felt in the thick walled vein. The axillary vein was completely excised in order to reach well beyond the visible limits of the phlebitis. The blood culture was negative promptly after operation. A pyoarthrosis of the right shoulder proved by aspiration, subsided spontaneously. Two metastatic foci, the evolution of which was watched until they resulted in localized abscesses in the soft parts, were treated by simple incisions. Pulmonary manifestations interpreted as probably due to embolic abscesses of the lungs cleared up and the patient recovered and has remained well.

The case illustrates as well the management of metastatic foci as already outlined. The metastatic foci do not always present as simple a problem as they did in this case. They may require as careful study as the original suppurative lesion, and extensive operations may be necessary.

Although treatment of a remediable local lesion is the vital step, general supportive measures are essential in the effort to aid in the recovery of the patient. Transfusion of blood for the relief of anemia and as a form of administration of nour-

ishment has its definitive place. The much debated question of its specific value in the treatment of sepsis need not be discussed, but we would say in passing that we have not seen any evidence of its aid in overcoming sepsis and do not employ blood transfusion for that purpose. The patient should be placed on a full diet regardless of the presence of fever. The value of fresh air and sunlight is generally appreciated. We strongly favor the administration of whiskey in large doses if possible. Opiates should be freely administered, for prolonged rest and sleep assist in improving the general condition. Dressing of wounds should be rendered as nearly painless as possible, inhalation anesthesia or avertin being desirable for dressings that would otherwise be prolonged and painful. The most valuable general supportive measure, in our opinion, is the continuous administration of intravenous glucose solution. The method is of greatest aid in patients who are unable to take nourishment, but is also useful for those who can take some food. In our opinion it should never be omitted in the first critical days in grave cases regardless of whether or not an operation for the suppurative focus has been performed. Continuous intravenous glucose solutions have been administered for 3 or 4 days in many of our cases, as well as for longer periods up to 12 days in a few cases. We have gained the impression that the method is not only of great aid as a supportive measure, but is also of value in combating the septic state.

## TECHNIQUE FOR COMPLETE LACERATION OF THE PERINEUM

JOSEPH E. JOHNSON M.D. MEMPHIS, TENNESSEE

IN the repair of complete laceration of the perineum, the reconstructive procedure includes the lower vagina, the transversus perinei muscles, the perineal body or the central tendon of the perineum, and the sphincter ani externus. The extent of damage to the internal sphincter and the levator ani is always a variable factor to be met with. Tear into the rectum itself would come under the classification of recto-vaginal fistula, and it will not be considered here.

Patients come to us for relief when this condition is present, not usually because of vaginal or cohabital distress, but because of the continual discomfort and embarrassment both to them selves and their friends and relatives resulting from gaseous and fecal incontinence. Therefore as far as the patient is concerned, no matter how expert and beautiful may be our operative measures for reconstruction of the pelvic outlet, the result entirely depends upon the ultimate integrity and capability restored to the anal sphincter. Many of the unsatisfactory results in perineal surgery can be traced readily to the oversight or neglect of a partially damaged or completely torn external sphincter muscle. Howard Kelly writes

I have heard T. A. Emmet state that he devoted more time and thought to the union of the sphincter muscle than to almost any other question in gynecology. We might conclude from this statement that many men less capable than Emmet might even find difficulty in knowing what to do with a torn or damaged external sphincter.

It is my purpose, in this paper, to dwell mainly upon the nature of the construction of the external sphincter and a method of its reconstruction hitherto unpublished. In my many dissections of the perineal musculature, I was long ago impressed with the morphology and anatomical structures of this muscle. Most textbooks picture it as a fat, circular band of voluntary muscle fibers, surrounding the anus showing its blind origin at the anococcygeal ligaments, with its insertion fading into nowhere, in the region of the central tendon of the perineum, sometimes blending or decussating about the bulbocavernosus muscle or just circling the anus. Actually, it can be dissected out, in its major portions as two elliptical flat muscle bellies, about 10 centimeters long and 2 centimeters wide with tendinous

origins at the anococcygeal ligaments and tendinous insertions into the central tendon of the perineum. In other words, the main portion of the sphincter and externus is composed of two independent, almost parallel, muscles including the anus between them (Fig. 1). Another common observation about perineal tears, in relation to this muscle is that rarely is the muscle ever torn through either of its bellies. There is merely a split in the area of the central tendon of the perineum causing not only a retraction of both bellies of the transversus perinei muscles and the bulbocavernosus but also of the bellies of the sphincter muscles. Normally the sphincter is in a constant state of tone or contraction. Hence, being torn from the central tendon attachment and insertion it is drawn toward its origin, which phenomenon is evidenced by the anal dimple or depression on either side of anus, a common observation. In its apparent inactivity, this muscle is in a state of chronic contraction. It may be weeks, months, or years before the patient presents herself for repair and during all this variable

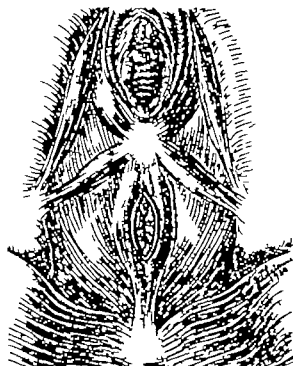


Fig. 1. Line drawing revealing actual demonstration of the double-bellied nature of the sphincter ani externus muscle, with its attachments to the coccygeal tip and the central point of the perineum.

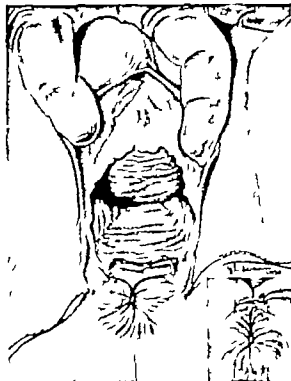


Fig. 2. Insertion of the No. 4 catgut suture into both dimples of the torn muscle bellies. Cut shows the looseness of the tied suture.

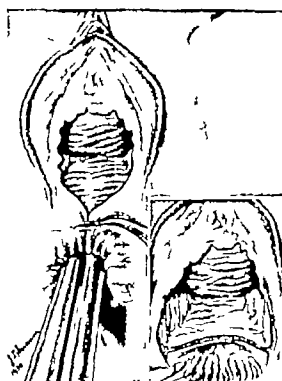


Fig. 3. Rectal dilator inserted into anal canal, with the suture properly placed, dilatation up to 3 to 4 centimeters in diameter easily possible. Cut shows beginning of repair.

period the sphincter parts remain in this state of chronic contraction. It is evident, therefore, that, before repair can rationally be done, this muscle be restored as nearly as possible to its original length. Kelly recommends division or stretching by means of tenacula, or Allis forceps. Crossen, also Ristine, recommend tenacula for this procedure. In addition Kelly states that the muscle fibers be bared from the scar tissue envelopment about its torn end before stretching is done. As a result of improper handling of this seemingly unimportant step in such a major procedure as the repair of complete laceration the sphincter is usually stretched but little or practically none at all and the patient if she does not tear through entire sphincter repair at the first defecation, suffers thereafter from dyschezia or obstipation for the rest of her life, because of the small hypertonic sphincter.

Many years ago Dr. T. J. Crawford, an old friend and colleague, former professor of gynecology at the old Memphis Hospital Medical College, an able surgeon and gynecologist, taught me a method of dividing this muscle which I have

used ever since his revelation, with great satisfaction and with excellent results. He did not publish his method nor his results, but in honor to his memory and because of its importance I thought it worthy of permanent record.

The dimple on the perianal skin represents not only the "scar tissue envelopment" at the muscle end, but also the torn fascial and tendinous insertion of the sphincter muscle belly. And the first step that is undertaken, necessarily is the use of this very tissue in the dimple, in the division of the sphincter muscle. This is done by passing a No. 4 catgut suture on a heavy full curved, cutting needle through the full depth of both dimples, and then tying securely approximating the dimples to each other. This suture, being large has a great primary tort, and it will not tear through the fascia, the muscle, or the thin anal skin (Fig. 2). Then, with the rectal dilator the muscles are slowly and carefully stretched (Fig. 3). Then the suture is cut and withdrawn. This dividing procedure paralyzes the muscles for a period of about 10 days, and soon the muscle assumes its original tone.

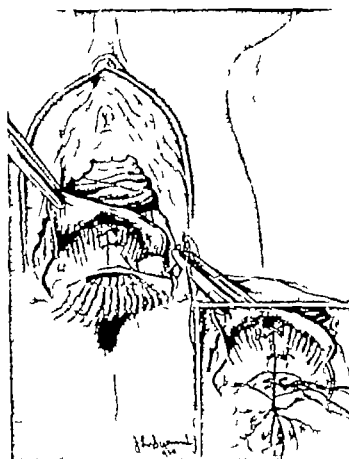


Fig. 4. After dissection of the vaginal flap, and repairing the levator ani the untraumatised fibrous ends of the torn sphincter and muscle are united with a figure-of-eight chromic suture. In cut, the figure eight suture *in situ*.

By means of the Barrett method of perineal repair rather than the classical Emmet or Tait (Fig 3), denudation is then proceeded with. The torn or separated fibers and fasciae of the levator ani, the bulbocavernosus, the transversus perinei and the internal sphincter are then dealt with in the customary manner and lastly the fascial ends of the sphincter muscles are carefully isolated. Since all voluntary muscles have fasciotendinous terminations, any denudation or baring of the muscle ends, as recommended by Howard Kelly may entirely destroy the function and power of the muscles. Hence, I would warn that this fascial and connective tissue cap, on the ends of the muscles be left untouched (Fig 4). The ends of both muscles are then picked up with a hard

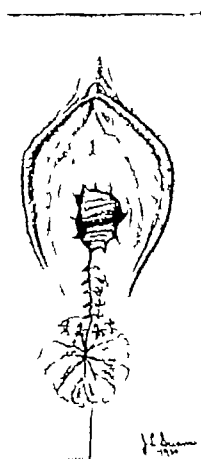


Fig. 5. Sphincter repair and perineorrhaphy completed.

chromic No. 1 catgut suture, the suture being carried through twice on both ends and tied securely great care being used not to strangle the ends but merely to approximate them (Fig 4).

After paring the excess of vaginal mucosa away the subcuticular tissues are then sutured with interrupted chromic sutures, and finally, the mucosa of the vagina and the skin are likewise approximated (Fig 5).

I am indebted, for the illustrations, to Mr. Joseph I. Schannl, artist, University of Tennessee Pathological Institute.

#### REFERENCES

- BARRETT C. W. *Am. J. Obst.*, 1909, lix 553  
 CROSWEN H. S. *Diseases of Women*. 6th ed. St. Louis  
 The C. V. Mosby Company 1926  
 EMMETT T. A. *Med. Rec.* 1873, viii 121  
 KELLY H. A. *Lewis' Surgery* 1929, ix, 5 6.  
 RUSTINE, J. C. *Am. J. Obst.* 1900, xii 365.

## MAJOR FRACTURES OF THE TIBIA AND FIBULA

## AN APPARATUS AND A METHOD OF TREATMENT

R. A. GRISWOLD M.D. F.A.C.S., LOUISVILLE, KENTUCKY

From the Department of Surgery of the Louisville City Hospital and University of Louisville School of Medicine

THE successful treatment of fractures presents two main problems: first, accurate anatomical replacement of fragments and second, strict maintenance of this position until healing occurs. In fractures of the tibia and fibula the displacements to be corrected and controlled are (1) longitudinal, (2) rotary, (3) angular and (4) transverse. The most important of these is correction of longitudinal displacement or shortening, which will usually but not always, bring the fragments into approximate alignment in the other respects. This is due to the squeezing effect of taut muscles and fascia at the fracture site. Reduction may be completed by bringing the distal fragment into line with the proximal. The position of the proximal fragment is determined by the balancing of muscle pull, or better by accurate mechanical control of proximal as well as distal fragments. Once manual or mechanical reduction is accomplished the position may be maintained by applying a splint or plaster cast, allowing the patient up on crutches. However, unless the fragments can be firmly locked in position, displacement may occur during or after application of the dressing. It is a rare assistant who can maintain position and effective manual traction for any length of time. Again even if post-reduction roentgenograms show good position, it is not unusual to find that as the swelling goes down the cast becomes loose and the fragments slip from position. Treatment by continuous traction in bed is open to several objections. It does not give accurate control of fragments, it entails long hospitalization, and in practice is not ideal for the reason that no form of traction is more efficient than its countertraction. To rely on the weight of the body and its friction on the bed for countertraction is to invite displacement, discomfort, and repeated, time-consuming adjustments. Anyone who makes rounds on a fracture ward early in the morning and sees the foot stirrups resting on the pulleys will appreciate this. The Thomas splint type of counterpressure against the ischium is of service only for first aid or transportation. Effective counterpressure exerted thus over an extended period, confines the patient to bed and often becomes obnoxious to him and the nurses, especially if he is obese.

The development of skeletal traction by Boehler and others has greatly improved fracture treatment by providing a more precise and effective reposition of fragments. Utilizing the principles of treatment advocated by Boehler we have attempted to modify and adapt his methods to our needs on a crowded city hospital service. The objectives sought were accurate reduction, firm fixation, and ambulatory treatment. To attain these ends, it seemed advisable to develop a simple device which would provide (1) positive skeletal traction and countertraction, obviously best obtained by steel pins above and below the fracture, as used by Caldwell; (2) firm fixation of the proximal fragment and accurate control of position of the distal fragment in all dimensions; (3) roentgenographic or fluoroscopic check of position before application of permanent dressing; (4) maintenance of position during and after the application of the permanent dressing; and (5) ambulatory treatment at the earliest moment.

The apparatus here presented (Fig. 1) has fulfilled these requirements and permitted reduction with precision comparable to that exhibited by a machinist adjusting a lathe, or a cabinet maker fitting a mortised joint. It consists of a rectangular gas pipe frame on a wooden base. On each side of the frame near the proximal end, is an adjustable device *a* for holding the steel pin which pierces the proximal fragment. Distally there is mounted the caliper for controlling the distal fragment by a pin through the os calcis or tibia. This pin is engaged by movable clamps, *b* which can be adjusted on the bars of the caliper. A cone clutch, *c* permits rotation and the whole is moved in the long axis of the apparatus by a screw *d*.

The technique employed is as follows:

1. Inject a local anesthetic (1 per cent procaine) into the fracture hematoma and pin sites and insert the pins after the method of Boehler. One pin is placed just below the tibial tubercle the other through the os calcis or lower tibia.

2. Fix the pins in their receptacles in the apparatus.

3. Adjust the clamps on the proximal pin so that the proximal fragment is in the axis of the apparatus.

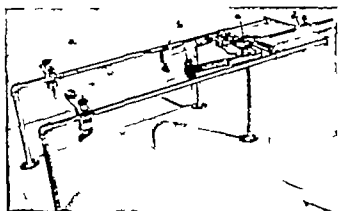


Fig. 1

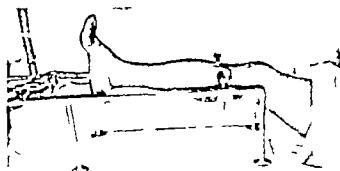


Fig. 2

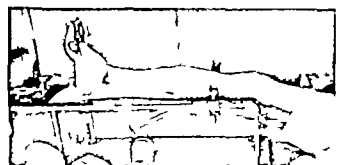


Fig. 3



Fig. 4

Fig. 1 Details of the apparatus. *a* The device for holding and adjusting the proximal pin *b*, caliper for holding and adjusting the distal pin *c* cone clutch which corrects rotary displacement, and *d* screw for applying traction.

Fig. 2 Pins in place through the proximal fragment and on calcals with collodion dressings. The fracture has been reduced and the limb is ready for the application of a cast.

Fig. 3 Anterior and posterior splints have been applied and accurately molded to the contour of the limb.

Fig. 4 The cast has been completed by circular plaster bandages, the limb removed from the apparatus, a walking iron incorporated and the ends of the pins covered with corks and plaster. The location of the fracture is marked on the cast to aid the X ray technician.

4. Adjust the clamps on the caliper to bring the distal fragment into the axis of the apparatus

5. Apply traction by means of the screw

6. Correct rotary displacement by the cone clutch

7. Readjust the pin clamps to correct residual angular displacement.

8. Apply a collodion dressing about the pins (Fig. 2)

9. Check the reduction by roentgenogram or fluoroscope

10. Apply a non padded cast from toes to upper thigh closely incorporating the pins.

11. After the plaster has set remove the limb from the apparatus, cover the ends of the pins with corks and plaster and incorporate a Boehler walking iron in the cast.

In some simple fractures with extensive soft tissue damage, it is our custom to leave the limb in the apparatus from 24 to 48 hours after reduction to allow swelling to subside before applying plaster. The details of application of the cast are important. One layer of flannelette or silence

cloth is applied about the upper thigh to prevent friction from the sharp edge of the cast. An anterior plaster splint is fitted from the base of the toes to the upper thigh directly on the skin and accurately molded to the contour of the limb.

A similar splint is applied to the posterior surface and extended one half inch beyond the toes. The edges of these splints are cut opposite the pins and at the heel to allow molding (Fig. 3). Circular plaster bandages are then applied from the base of the toes to the upper ends of the splints closely incorporating the pins. This plaster is allowed to set before traction is removed and the limb taken from the apparatus. If the fragments are firmly locked in position, the pins may be removed as soon as the plaster has set. However, most oblique comminuted or compound fractures require better fixation. In these cases the pins remain in place for 3 or 4 weeks, the sharp ends being protected by corks held with plaster. Boehler walking irons are used in almost all cases (Fig. 4). Some transverse fractures of the lower third of the tibia and fibula do not require fixa-

tion of the knee by plaster, the cast extending only to the tibial tubercle, but firmly fixing the upper pan. The patient is kept in the hospital for 24 or 48 hours after the application of plaster. During this period the extremity is carefully observed for circulatory embarrassment and the cast split along its anterior surface if necessary. This may be done without disturbing fixation in any way. Then, when the swelling subsides, a circular layer of plaster reapproximates the edges. The patient is discharged on crutches and starts weight bearing on the walking iron immediately.

In compound fractures the wound is covered with a sterile dressing and the usual technique followed through step 4 under spinal or general anesthesia. The skin surrounding the wound is prepared with green soap, iodine and alcohol and the field draped. Complete débridement is carried out, the wound edges all dirty and bruised soft tissues and dirty or devitalized bone being removed. Reduction is completed by an assistant who adjusts the apparatus under the direction of the surgeon. Accurate reposition of fragments is thus obtained without levering or manipulating the bone in the wound, a procedure which would devitalize bone and increase contamination. No sutures and few ties are used beneath the skin. Hemorrhage is controlled by leaving hemostats in place for a few minutes. The absence of foreign bodies has, we feel, a definite influence on healing without infection. The skin is closed with interrupted silk sutures, appropriate relaxation incisions being made if necessary for closure without tension. Dressings are applied and the limb maintained in position in the apparatus from 72 to 96 hours. If there are no constitutional signs of sepsis during this time, the dressing is changed, the wound inspected, and if no infection is present, plaster is applied and the treatment is continued as for a simple fracture. The skin sutures usually remain in place until the pins are removed

and the cast changed after 3 or 4 weeks. If signs of infection appear during the period of observation, the wound should be opened widely and debrided or the Orr treatment carried out. In an occasional case serious contamination or established infection on admission contra-indicates primary closure. Such fractures should be reduced and débrided as described and debrided or dressed by Orr's method from the start. We prefer the Orr method.

It should be emphasized that débridement and primary closure is not a procedure to be carried out in the dressing room by an interne. To avoid infection and obtain primary union, this procedure must be performed with the ritual, personnel and meticulous technique of any major bone operation.

The patient is seen in the outpatient department at weekly or bi-weekly intervals. Weight bearing is permitted from the start with the aid of crutches and then a cane. This helps prevent atrophy of soft tissues and aids healing. At the end of 3 or 4 weeks, the fragments have "stuck" sufficiently to permit the safe application of a snug new cast and the removal of the pins by the following procedure. The plaster and corks are removed from the pins, and the extremity is placed in the apparatus under slight traction. The old cast is removed and a new one applied the same technique being used as before except that the pins are not closely surrounded with plaster. As soon as the plaster has set traction is released, the pins and skin about them are cleaned with iodine, and the pins are removed. This method prevents motion and displacement of fragments while changing casts. The walking iron is reapplied and worn for another 4 to 6 weeks.

#### REFERENCES

1. BOEHLER, LORENZ. *The Treatment of Fractures*. Vienna: Wilhelm Maudrich, 1932.
2. CALDWELL, JOHN A. *Ann. Surg.*, 93:3, 205-216, 1916.

## ILIAC CARCINOID

## CASE REPORT WITH OBSTRUCTION RESECTION, AND RECOVERY

FREDERICK CHRISTOPHER, M D., F.A.C.S., WONNETKA, ILLINOIS

Associate Professor of Surgery Northwestern University Medical School, Chief Surgeon, Evanston (Illinois) Hospital

THE term "carcinoid" was first applied by Oberndorfer in 1907 to the small relatively benign epithelial celled tumors found chiefly in the appendix (particularly the obliterated type) and less frequently in the small bowel, colon, rectum, and Meckel's diverticulum. They were first described in 1888 by Lubarsch who thought them, however, to be primary carcinoma. According to Pack and Davis the ileum comes next in frequency after the appendix. The work of Masson has definitely established the pathogenesis of these tumors. This author considers them to be

intraneuronal argentaffin cells springing from the epithelium that lines the bottom of the glands of Lieberkuhn. The granules of the carcinoid cells, while unstained by ordinary methods, reduce a solution of ammoniacal silver (Stout). While argentaffin, the carcinoid cells are also chromaffin (McGlannan and McCleary).

According to Gaspar there were records of some 70 cases of carcinoid of the small intestine up to 1930. This author reported a case of multiple carcinoid tumors of the jejunum one of which caused intestinal obstruction and had metastases to the mesentery and liver. Stout's case occurred in a male of 55 years who had suffered for 2 months from abdominal cramps, diarrhea, and loss of weight. Forty-seven centimeters of ileum containing two masses 13 centimeters, apart was resected. The lumen of the bowel was obstructed and there were metastases in the mesenteric lymph nodes. The patient died from peritonitis one week after the operation. In the case of Pack and Davis there was metastasis in a mesenteric lymph gland. In 1926 Dukes and Lockhart Mummery reported the case of a 76 year old woman with no intestinal disturbance who recovered following resection of the cæcum. There was a carcinoid tumor at the ileocecal valve with metastases to the peritoneum, liver and regional lymph glands. Planson's (11) case is of interest because the first manifestation was an iliac and crural adenopathy. The enlarged glands were excised and recognized as carcinoid metastases. Five months later intestinal symptoms appeared and the patient recovered after a resection. According to Stewart and Taylor metastases are relatively infrequent. They found only 18 cases

including their own in a careful search of the literature up to 1926 in which some hundreds of cases had been published. They found the sites of the metastases in the 18 cases to be as follows: peritoneum 12, regional lymph glands, 6, liver 7, pleura, 1. Hasegawa describes 4 cases of carcinoids of the small intestine. Decker a case of multiple intestinal carcinoids and Wolfer a 6 millimeter carcinoid of anterior wall of duodenum. Wolfer states the average age as 50 years.

In 1927 Heine reported what he believed to be the first case of carcinoid of the small intestine which caused ileus and death. In this patient a woman of 81 years, there had been moderate symptoms of intestinal obstruction for 3 months. Vomiting started a few days before admission and patient died 24 hours after operation. The car-



Fig. 1. Roentgenogram taken 8 hours after barium meal showing marked distention of small bowel due to obstruction near the ileocecal junction. Note that some barium has entered the colon.





Fig. 2. Photograph of specimen excised at operation. Note the annular constriction of the bowel produced by the carcinoid tumor.



Fig. 3. Photograph of specimen which shows the cut end of the tumor at site of annular constriction of the small bowel.

cinoid was of walnut size, was situated at the mesenteric border and caused stenosis. There were no metastases in the neighboring lymph nodes.

The rarity of intestinal carcinoids warrants the recording of the following case. It is of interest particularly because of the intestinal obstruction, resection and recovery and because of the apparent absence of metastases.

Mrs. G. P., aged 35, was first seen on July 12, 1933, with a history of intermittent abdominal pain. She was referred to Dr. Lowell D. Snoff for study of the gastro-intestinal tract. She was admitted to the Evanston Hospital on July 13, 1933. The patient complained of severe intermittent attacks of abdominal pain—chiefly epigastric. Three years previously the patient had an attack of pain 3 hours after her evening meal. A hypodermic was given for pain. There were two or three similar attacks up to 3 months ago and two severe attacks since. Patient spoke of a "knot" in the epigastrium which was relieved by warm compresses. The discomfort was less in the morning and less after the passage of gas. There was more trouble from gas when the patient lay on her side. At a previous operation an ovarian cyst, a tubal pregnancy and the appendix had been removed. There were findings in the history suggestive of cholelithiasis, duodenal ulcer and diverticulitis. The patient was somewhat obese and the physical examination was negative save for tenderness in the lower left quadrant. The benedictine test for blood in the stool was positive. The urine was negative. Hemoglobin was 80 per cent; red blood count 4,490,000; white blood count 9,700. Wasserman

mann and Kahn negative. Dr. James T. Case in the report of the X-ray examination said: "there is quite evidently a gross lesion in the small intestine somewhere near the ileocecal junction (Fig. 2)." The type of obstruction is a matter of conjecture from the X-ray standpoint. It might be a Meckel's diverticulum with some obstruction phenomenon. It might be a volvulus of the terminal coil of the small bowel. It might be a primary carcinoma, or if the patient has had a pelvic operation, it would be most likely an adhesion following an old pelvic operation.

On July 15, an exploratory laparotomy was carried out under ethylene and drop ether. When the abdomen was opened distended loops of ileum presented. By following these along distally the obstruction was readily found at a point about 8 inches proximal to the ileocecal valve. Here the bowel was greatly narrowed (Fig. 3) as if tight band had been around it. No adhesion, however, was evident. The lymph glands in the adjacent mesentery were hard and enlarged to a size of one to 1.5 centimeters. The pathologist, Dr. Francis D. Gunn, who was present, felt that the condition, if malignant, had progressed so far that a radical attempt to remove all the lymph glands would be ineffectual and futile. Accordingly a section of ileum some 24 centimeters in length and including the affected area was excised at the mesenteric attachment. Because of the immobility of the cecum and the portion of the ileum distal to the stenosis the distal section of the bowel could be made only about 1 inch distal to the constriction. On cutting into the gross specimen (Fig. 3) Doctor Gunn pronounced it benign but on examination of the frozen section was inclined to think that we were dealing with a malignant growth. The lumen at the site of the constriction was about 1 centimeter in diameter. The cut ends of the bowel were



Fig. 4. The epithelium of the small bowel and below it, in the submucosa, the invading masses of carcinoid cells.

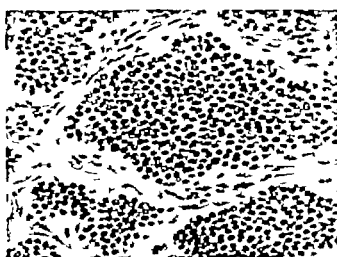


Fig. 5. Photomicrograph showing carcinoid cells infiltrating stroma of the submucosa.  $\times 300$

then turned in and a lateral anastomosis was performed. The mesenteric opening was closed. An ovarian cyst was palpated in the left pelvis. It was densely adherent to the surrounding structures. On breaking into it a clear fluid escaped. The length of the operation and the patient's condition precluded the dissection necessary for the excision of this mass and it was left in place. The abdomen was closed with cigarette drainage in place. Save for some infection at the site of the drain the convalescence was uneventful and the patient was discharged from the hospital on August 1, 1933. She gained strength rapidly at home and soon was completely recovered.

The report of the pathologist, Dr. Francis D. Gunn: "This specimen consists of a segment of a small bowel measuring 24 centimeters in length. The mesentery has been amputated close to the intestine. The greater part of the intestine is dilated and has a maximum circumference of 12 centimeters. Near one end, there is a constriction produced by a narrow fibrous band which almost completely encircles the intestine and is indicated by a narrow circular groove on the serosal surface. On the other side (distal) of this constriction, the circumference of the bowel is much less (about 5 centimeters) and the intestinal wall has a normal thickness. The serosa of the entire segment is diffusely hyperemic and the fibromuscular wall is approximately double the normal thickness in the dilated segment. The lumen is filled with semi-liquid greenish brown fecal matter. The mucosa in the dilated segment is markedly edematous and diffusely hyperemic, but not ulcerated. The lumen in the line of constriction is about the diameter of a lead pencil and the mucosa, which lines the constricted portion, is thickened, but not ulcerated.

"Sections (Figs. 4 and 5) of the intestinal wall made transverse through the ring of constriction show an intact mucous membrane with a moderately dense leucocytic infiltration of the stroma consisting of large numbers of plasma cells and eosinophils and a smaller number of polymorphonuclear neutrophils. In the submucosa, there are compact masses of small polyhedral cells resembling epithelial cells arranged in the form of thick cords and irregular branching trabeculae. The cells are strikingly uniform in size with dark round nuclei about 7 or 8 microns in diameter with finely granular chromatin. The cell boundaries are indistinct and the cytoplasm rather scanty. No mitotic figures are seen. The stroma consists of a moderately dense, fibrous connective tissue which constitutes about 50 per cent of the tumor bearing tissue and divides

the masses of tumor cells into small lobules and strands. A few small lobules extend into the mucosa as far as the fundi of the glands. Many slender strands and a few thick masses of similar cells extend into the muscularis between the muscle bundles. In the serosa, there are poorly circumscribed nodules of tumor tissue which have about the same proportion of stroma as that in the submucosa. The fibrous trabeculae between the cords of tumor cells contain numerous fine capillary blood vessels. Very small masses of tumor cells are found in the serosal fat.

The lymph node from the mesentery shows hyperplastic germinal follicles with a relative increase of histiocytes and generally hyperplastic small lymphoid cells, but no tumor cells can be found in any of the sections examined.

"The uniformity in size, shape and staining reaction, the absence of mitotic figures in the tumor cells and the absence of metastases to regional lymph nodes indicate a very low grade of malignancy.

"Diagnosis. Annular carcinoid tumor of the small intestine with incomplete obstruction of the lumen. Dilatation of the proximal segment of the intestine with mild fibrous peritonitis. Subacute lymphadenitis of the regional mesenteric lymph nodes."

## BIBLIOGRAPHY

1. DECKER, P. *Rev. méd. de la Suisse*, 46, 292.
2. DUKES, C. and LOCKHART MUMMERY, P. *J. Path. & Bacteriol.* 1926, xxix, 303.
3. GASPARD, I. *Am. J. Path.* 1930, vi, 515.
4. HASEGAWA, T. *Arch. f. path. Anat.* 1923, ccxlii, 8.
5. HIRN, J. *Deutsche Ztschr. f. Chir.* 1927, ccv, 126.
6. LUBARSCH. Quoted by Gaspar. *Arch. f. path. Anat.* 1888, lli, 28.
7. MASSON, P. *Am. J. Path.*, 1928, lv, 181.
8. McGLADNAN, A. and McCLEARY, S. *J. Am. M. Ass.* 1927, lxxxix, 850.
9. OBERNDORFER, FRANKFURT. Quoted by Gaspar. *Ztschr. f. Path.*, 1907, l, 426.
10. PUCK, GEORGE T., and DAVIS, A. H. *Am. J. Surg.*, 1930, lx, 472.
11. STEWART, M. J. and TAYLOR, A. L. *J. Path. & Bacteriol.*, 1926, xxix, 136.
12. SROUT, A. P. *Human Cancer*, p. 305. Philadelphia, Lea and Febiger, 1932.
13. WOLFE, J. A. *Surg., Gynec. & Obst.*, 1928, xlvii, 643.

# FENESTRÆ AND POUCHES IN THE BROAD LIGAMENT AS AN ACTUAL AND POTENTIAL CAUSE OF STRANGULATED INTRA-ABDOMINAL HERNIA

REPORT OF TWO CASES WITHOUT STRANGULATION WITH REVIEW OF LITERATURE

ARTHUR B HUNT M D CHICAGO

Resident in Obstetrics and Gynecology From the Department of Obstetrics and Gynecology The University of Chicago

IN recent years attention has been called to several cases of intestinal strangulation through defects in the broad ligament. A review of the subject was stimulated by encountering recently two cases in which an aperture of the broad ligament was found, without strangulation.

## HISTORICAL

The literature, prior to 1917 reveals the absence of a single case report of intestinal obstruction by incarceration of the intestine in pouches or fenestræ of the broad ligament, wherein surgical treatment was instituted. This condition was first mentioned in 1861 when Quain reported the autopsy findings in a woman who died of intestinal obstruction by strangulation in an opening of the right broad ligament.

Eve in 1885 quotes Sir William Lawrence's reference as vaguely referring to possible cases. Treves in 1885 in a classical description of the intestines and peritoneum, with reference to hernia, failed to mention broad ligament malformation as being responsible for intestinal strangulation. Barnard in 1910, referred to a specific case at the London Hospital but Piddock was unable to obtain details concerning it.

The first reliable surgical cases to be reported were 2 by Fagge, in 1917. He was followed by Bar in 1920. Richardson, in 1920 reported the first instance of this type of hernia following the Baldy Webster operation. Piddock reported a case in 1924, and Dunn in 1926, the latter reviewed the literature and added clinical remarks. Subsequently 8 other cases appeared (3, 4, 5 11 17 21). Thus, a total of 14 authentic cases have been described up to July 1 1933 9 being clinical.

## INCIDENCE

This form of intestinal strangulation appears to be excessively rare. It is rare even when compared with the uncommon forms of intestinal strangulation into the other peritoneal fossæ and apertures. Dulles, as early as 1889, had collected more than 70 cases of properitoneal hernia, and in 1906 Moynihan reported 81 authentic cases of hernia into the duodenal fossæ—15 of paracæcal hernia,

and 12 of strangulation in the foramen of Winslow. Judd in 1929, found 29 cases of strangulation through holes in the mesentery. Pemberton and Sager state that 16 of 100 cases of intestinal obstruction seen at the Mayo Clinic followed pelvic operations, but all were caused by adhesions. Nevertheless, one is inclined to agree with Dunn that this condition is more common than the reported cases would suggest. This is indicated by the fact that 3 of the 12 authors have reported 3 cases each from their own personal experience. In this clinic we have also encountered 2 cases without strangulation.

Reports of defects in the broad ligament unassociated with strangulation, with two exceptions, seem to be entirely wanting. Hermann, in 1915, reported bilateral pouches encountered during the removal of a pelvic tumor from a nulliparous girl of 18 years. There was no evidence of previous acute inflammatory process. This case is strongly suggestive of congenital origin. Pemberton's and Sager's second case showed bilateral holes at the points where the round ligaments were brought through the broad ligament in a Baldy Webster operation without strangulation.

## ETIOLOGY

The Baldy Webster operation was definitely the cause of three of these hernias. The authors of this operation pointed out the wisdom of suturing the openings through which the round ligaments are led. Neglect of this step obviously increases the risk of a defect with dangers of strangulation.

No certain statement may be made as to the etiology of these defects, nor can definite conclusions be reached until more cases have been studied. Three theories have been cited, with more or less repetition namely (1) congenital anomalies (2) internal lacerations, as the result of pregnancy or labor and (3) defects resulting from previous inflammatory processes (generalized or pelvic peritonitis with attendant adhesions and distortions of structure).

Eight of the twelve women requiring laparotomy for strangulation were parous, and with but

TABLE I.—DIAGNOSTIC DATA

Case	Age	Cavities	Para	History of fall or fall	Previous attacks of abdominal pain	Pelvic mass	Pelvic tenderness	Previous Bucky Webster operations
Quinn	16			+	Intolerance	+	+	
Fagge (1)	6	v	v	+		+	+	
Fagge (2)	40	o			o			o
Bar	44	xi	vi				o	o
Richardson	42	?	?	o				+
Piddock	34	Parous	Parous	+			o	o
Dunn	44	vii			+	+	+	o
Dorman	?	Multiparous	Multiparous		?	?	?	o
James (1)	58	Parous	Parous		+	+	+	o
James (2)	36	vii	vii		+	+	+	
Caplan	36	?	?		+	?		
Cooper	70	Multiparous	Multiparous	o		?	?	
Stinson	50	o	o			o	+	o
Pemberton and Sager ( )	30	?	?			+	?	+
Pemberton and Sager ( )	36	?	?	?	?			+
Herman	8	o					o	o
University of Chicago (1)	60	v	li					o
University of Chicago (2)	5	lii	lii		o	o	o	o

one exception all of these were multiparæ. In two instances parity was not stated. In the primiparous woman, strangulation occurred early in the puerperium. Younger women were not involved, the youngest being 30 and the oldest 70 the average age was 52. This might indicate that a loss of tissue elasticity caused the stretching of pre-existing pouches or tearing of the thin and less resistant broad ligament (especially the thin mesosalpingeal portion, where most of the holes were found to occur). The distention, attendant on pregnancy, or the development of a large ovarian cyst probably enlarges the pouches or tears the mesosalpinx. Piddock noted the ease with which the thin avascular mesosalpinx could be torn in cadavers, and believed that the strain of the enlarging gravid uterus or its sudden collapse after delivery might produce such a rent. If the pouches are of congenital origin they are due perhaps to a faulty union of the embryological elements forming the broad ligament. Kostanecki, in an exhaustive review of the development of the broad ligament, stated that lines of coalescence (between the medial and lateral portions of the wolffian mesentery and the phrenicomesonephric ligament) might be dissected on occasions, even in the adult. In no case in this group was evidence of previous pelvic

infection mentioned, except that in Quinn's autopsy report.

Among factors producing the actual strangulation may be mentioned straining at stool, falls, or other sudden trauma. Torsion traction, or other operative manipulation of the uterus during cesarean section may have caused the defect in our second case. This danger would seem more liable to occur if a transverse uterine incision were employed.

#### ANATOMICAL CONSIDERATIONS

The broad ligament is divided into two parts by the ligamentum proprium ovarii a smaller triangular upper portion, and a lower portion, usually thought of as the broad ligament proper. The upper portion—the mesosalpinx—is bounded medially by the uterus, superiorly by the fallopian tube laterally by the ovary, and inferiorly by the ovarian ligament. The lower portion is bordered by the uterus medially the ovarian ligament superiorly, the pelvic wall and the suspensory ligament of the ovary laterally and inferiorly by the pelvic fascia.

In these 17 cases the incidence of pouches occurred five times and openings twelve. The lesions were bilateral in three instances, once with pouches and twice with apertures. In the uni-

TABLE II—TYPE AND LOCATION OF DEFECT METHOD OF TREATMENT AND OUTCOME

Case	Defect	Site	Treatment	Outcome
Jones (autopsy)	Fenestra	Right	Autopsy only	
Fagge	Pouch	Left	Pouch cut, bowel freed. Pouch closed with continuous circular suture	Second laparotomy for adhesions 14th day postoperative. Recovery
Fagge	Pouch	Right	Pouch cut, converted into shallow fossa, no suture	Uneventful recovery
Har	Fenestra	Left	Hole enlarged with finger	Uneventful recovery
Richardson	Fenestra	Right	Adhesia removed	Uneventful recovery
Publack	Fenestra	Left	Hole enlarged by cutting. Right foot of bowel resected	Second laparotomy 16th day to drain pelvic abscess, path. dry peritonitis; abscess drained. Recovery
Dixon	Fenestra	Bilateral	Holes closed by suture	Serousoepithelium field drained from cut-down, 1 week postoperative. Recovery
Dezman	Pouch	Left	Pouch sutured	Uneventful recovery
James	Fenestra	Left	Hole enlarged with finger, closed with suture	Uneventful recovery
James	Fenestra	Left	Bowl of early dislodged by gentle traction	Death from cardiac complication 17 hours after operation
Coplex	Fenestra	Right	Tube and broad ligament severed	Recovery
Casper	Fenestra	Right	Freed by subperitoneum of early pregnancy tube	Uneventful recovery
Stimson	Fenestra	Left	Died during operation	Deceased
Pemberton and Sager	Fenestra	Left	Adhesia removed	Recovery
Pemberton and Sager	Fenestra	Bilateral		Recovery
Hermann	Pouches	Bilateral		Recovery
University of Chicago	Fenestra	Right	Salpingo-oophorectomy	Recovery
University of Chicago	Pouch	Left	Sutured, utilizing round ligament	Recovery

lateral defects the left and right sides were about equally involved, seven times on the right and eight on the left. Where the location of the openings was mentioned, they were situated above the ligamentum proprium ovarii twice, and below once. The pouches always occurred below the ovarian ligament, near the uterus. The length of the strangulated bowel varied from 2 inches to 8 feet, and in one instance "a greater part of the small intestine" was herniated through the fenestra.

#### DIAGNOSIS

A pre-operative diagnosis of this form of intestinal obstruction, to our knowledge, has never been made although once the diagnosis of intra abdominal hernia was stated. Three patients gave histories of long standing attacks of abdominal pain related to posture. In our second case the patient was nauseated and retched considerably exhibiting this disturbance more than is encountered during most cesarean sections under local anesthesia. It is conceivable that if more cases were reported this condition might be suspected in a multiparous woman presenting find

ings of intestinal obstruction associated with a tender pelvic mass. The abdominal pain was localized uniformly to the side of the hernia. History of a previous Baldy Webster operation would be significant.

Six of the 9 cases submitted for pelvic examination revealed tenderness on the side involved, and there were palpable masses in five. Vaginal examination under anesthesia might have revealed masses in the other cases (Table I). The subjective location of the pain was quite consistent with the anatomical location of strangulation, as found at operation.

#### TREATMENT

The treatment is obviously surgical, with prompt diagnosis of the obstruction materially strengthening the prognosis. Gentle traction on the bowel might free it, but in nearly all of these cases the opening required enlargement by the finger or the scissors. In all but 2 cases the bowel was thought to be in good condition, no resection being done, and later events proved the wisdom of this conservative treatment. Fagge, in one

case, merely converted a pouch into a shallow fossa and had occasion, some weeks later at a second laparotomy, to note the adnexa in a good condition and relatively safe from the possibility of a second incarceration. However, Dunn's remarks on the treatment seem sound. Namely in a younger woman the pouch or opening should be carefully closed by suture. In a woman past the menopause the adnexa might well be removed. If the blood supply of the tube or adjacent tissue (as in Dunn's case) is seriously impaired, removal is, of course, indicated (Table II).

#### PROGNOSIS

The cases herein reported suggest that the outcome as to life in this serious condition is excellent. Only two deaths occurred. One patient was obviously a poor risk, due to a serious cardiac complication, which later was the immediate cause of death. The second was moribund on admission.

The morbidity, however, was fairly high. Three patients experienced a stormy convalescence, two requiring subsequent laparotomies, and the third recovered only after the cul-de-sac was drained. One of these patients also developed a perinephritic abscess that required drainage.

While this series is so small that it precludes any definite conclusions, it does have the merit of being the only one available at present dealing with this rare but dangerous condition.

#### CASE REPORTS

**QUAIN'S CASE.** Patient, aged 36 years, iv para. Her youngest child was 9 years of age. The patient was taken with a sudden sharp pain in the left side while stooping to adjust a shoe lace. She gave a history of flatulence, but no other signs of bowel distress. Only one bowel movement was effected by an enema. Signs of peritonitis developed and the patient died 3 days after the onset of the pain.

At autopsy the lower part of the ileum was a deep crimson hue and some of its convolutions were chocolate colored and adherent to one another. The uterus was attached to the inflamed bowel by its broad ligament, and was also drawn up to the right side by previous pregnancy or inflammation of the broad ligament. The bowel was constricted at two places on the right side of the pelvis, at one by old adhesions between the broad ligament and the mesentery and at the other by an aperture in the right broad ligament. Forty inches of ileum had slipped through the latter opening, while 10 inches were incarcerated in the opening caused by the old adhesions.

**FAGGE'S CASE 1.** While straining at stool, the patient, aged 61 years, v para, was seized suddenly with abdominal pain referred to the left iliac region. She vomited several times. Tenderness low in the left iliac region was the only abdominal finding. No exact diagnosis was attempted. Under anesthesia, a vaginal examination detected a fullness of the left fornix, and rectal examination confirmed the presence of a mass in the pouch of Douglas. Abdominal incision exposed a purplish distended coil of ileum in the lower right portion of the abdomen, firmly fixed in the pelvis, which was traced to a small hole in the broad ligament on

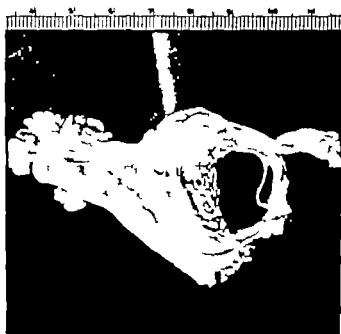


Fig. 1. Case 1. Photograph of gross specimen of left adnexa showing fenestra.

the left side. The margin of this hole was divided by the scissors and showed 10 inches of viable gut strangulated through it. The opening just medial to and below the ovarian ligament was closed with continuous catgut suture. Three months later severe abdominal pain necessitated a second laparotomy at which time extensive adhesions between the scar and lower ileum were freed. The opening in the left broad ligament, however had remained closed.

**FAGGE'S CASE 2.** The patient, aged 40 years, was seized quite suddenly with abdominal pain and vomited at intervals. On the following day she did not seem acutely ill, but vomited occasionally. On the fourth day vomiting continued accompanied by severe pain in the middle of the abdomen. There was, at this time, slight rigidity and tenderness over the right rectus, medial to McBurney's point. The pre-operative diagnosis was appendicitis. At operation a coil of lower ileum was fixed to the back of the right broad ligament. The upper border of the hernial sac was cut with scissors and 3 inches of ileum were released. The pouch was converted into a shallow fossa and closure by suture was not thought to be necessary. Recovery was uneventful.

**BAR'S CASE.** The patient, aged 44 years, gravida xi, vii para, menopause before present illness, was seized suddenly with a severe pain in the epigastrium. This was more severe to the left of the midline, and radiated down to the left pelvis. The pain was constant, with frequent accentuations. Nausea and vomiting were prominent symptoms. She was seen on the third day and found to be in excruciating pain, with the greatest tenderness in the left lower quadrant. There was excessive and persistent nausea also vomiting with the taking of food or fluid. Moderate abdominal rigidity was present. The patient had had no bowel movements during the past 48 hours. Digital examination was negative. Operation revealed that about 12 inches of small intestine had passed through an opening in the left broad ligament, with tight constriction at the orifice. Traction failed to dislodge the imprisoned bowel. The aperture was enlarged by tearing with the finger releasing the gut. The patient made an excellent recovery.

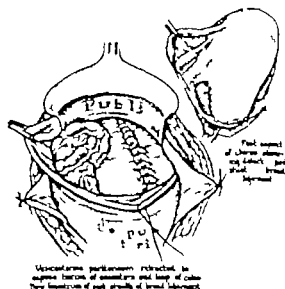


Fig. 2. Case 2. Drawing showing defect and hernia of bowel after the vesico-uterine peritoneum was incised; also posterior view of defect following extraction of the bowel.

**REMARKS.** The patient, aged 48 years, had had a Beldy Webster operation 3 years before present illness, which began with acute abdominal pain accompanied by nausea and vomiting. She had had no bowel movements for 3 days. On examination the abdomen was found to be distended and the outline of some intestine was visible. Vaginal examination was negative.

At laparotomy three or four inches of small intestine were found strangulated through a perforation in the right broad ligament. The left broad ligament appeared normal. The bowel was freed and the right tube and ovary were removed. Recovery was uneventful.

**PROBOSCH'S CASE.** The patient, aged 34 years, 7 para, had been delivered without complications 14 days prior to admission, following a normal pregnancy. On the morning of admission, she was seized suddenly with severe pain in the region of the navel, while bathing her child. The pain was continuous and very acute. After 3 hours, vomiting began and returned at intervals all afternoon, but was never fecal. There were no bowel movements or passage of flatus after the onset of the symptoms. Six hours later, examination showed the patient to be acutely ill and in collapse, complaining constantly of agonizing abdominal pain. The abdomen was lax and no distention or peristalsis was noted. On palpation slight tenderness and rigidity were discovered in the lower part of the left iliac fossa, but no masses were felt. On rectal examination the invading uterus was felt, but nothing abnormal could be detected. A diagnosis of acute intestinal obstruction was made. After restorative treatment had revived the patient somewhat, the operation was started. A reddish-black mass was visible underneath the peritoneum. A small band on the left side of the uterus, which seemed to cause the strangulation, was clamped and cut. Further investigation showed it to be the round ligament. The gut at the site appeared to be almost gangrenous, so it was resected, and a lateral anastomosis with the cecum was done. There was no evidence of previous pelvic infection or adhesions. Eight feet of gut were excised.

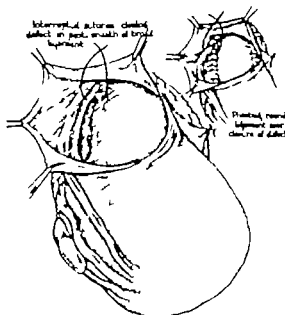


Fig. 3. Case 2. Semidiagrammatic illustration of two stages in the repair of the defect in the posterior sheath of the broad ligament.

Convalescence was satisfactory until the sixteenth day when the temperature rose to 105 degrees F and vomiting set in. Enemas were ineffective. The abdomen was again opened and an abscess in the upper left pelvis was drained. No obvious leakage from the anastomosis was found. Fourteen days following the second operation, a large right perinephritic abscess had to be evacuated, and from this time on recovery was uneventful.

**DUNN'S CASE.** The patient was 44 years old, 7 para. In 1904, she fell from a chair which apparently caused a miscarriage 3 days later. For over a year thereafter, she had severe lower abdominal pain when lifting or holding her child in her lap. The pain persisted for 15 years, when lying on her side, except when she was pregnant. Reaching upward caused an intense pain, followed by a sense of weakness, which might last for some time. Intercourse had been uncomfortable during the last 4 years. The patient had had four labors and two miscarriages since the time of the accident. When the abdomen was opened, masses of small intestine was found fixed in the left pelvis. Exposure disclosed 15 inches of small intestine projecting through a hole in the mesosplanch. This opening was of sufficient size to permit readily the withdrawal of the intestine. The aperture was closed with chromic catgut. Further examination of the pelvis located a similar opening of the same size in the right broad ligament. This aperture lay between the tube and the utero-ovarian ligament. No intestine occupied this opening, but the appendix lay parallel with it, and was attached to its lower margin. It was removed and the opening in the mesosplanch was obliterated, as on the left side. A survey was made of the left pelvis and since it was found that the left tube had become cyanotic from impairment of its blood supply, it was removed.

Convalescence was uneventful, the patient returning home at the end of 2 weeks. However on the way home from the hospital she developed an intense pain in the right

iliac region. A colpotomy was necessitated a week later at the point of tenderness and induration, with the release of a considerable quantity of serous exudate, but no pus. The patient made a rapid recovery and has been well since.

**DOLEMAN'S CASE.** The patient was a multiparous woman who had been operated upon 9 years before the present illness for a strangulated femoral hernia. Her present attack was characterized by acute abdominal pain, distention, absolute constipation, and fecal vomiting for 4 days. At operation some small bowel was found strangulated in a peritoneal invagination in the posterior aspect of the left broad ligament. The neck of the sac was excised, the bowel withdrawn, the sac closed by suture. Recovery uneventful.

**JAMES' CASE 1.** The patient, aged 58 years, a parous woman, had suffered repeated attacks of abdominal pain for the past 10 months. When James saw her during this attack, she had been suffering from acute abdominal pain for 24 hours, and had vomited repeatedly. On pelvic examination a moderately tender cystic mass was discovered posterior to the uterus. At operation about 15 inches of ileum were found prolapsed through a small opening in the left broad ligament. The opening was enlarged the gut liberated, and the orifice sutured. Recovery was uneventful.

**JAMES' CASE 2.** Three days before operation the patient, aged 36 years, vii para, had severe cramp-like abdominal pain, with an apparent obstruction developing. Tenderness was elicited in the left lateral fornix. In spite of an auricular fibrillation and a pulse of 140, it was decided to open the abdomen. The condition of the patient permitted no further exploration than to free a loop of bowel which was constricted near the uterus on the left side. Death occurred from cardiac failure 17 hours later. At autopsy an opening of 1.5 centimeters in diameter was found in the left broad ligament.

**COTLAR'S CASE.** The patient, aged 56 years, had had recurrent attacks of vomiting for 10 days, followed by an acute attack of abdominal pain after absolute constipation for 3 days. The right side of the abdomen was rigid and tender. At operation 6 inches of gut were strangulated in an opening in the right broad ligament. The opening was abolished by sewing the tube and broad ligament superior to the opening. Recovery was uneventful. The author had an opportunity to see the pelvic viscera at a laparotomy 3 years previously and stated that the broad ligament was then normal.

**COOPER'S CASE.** The patient was aged 70 years, the mother of grown-up children. Three days after the onset of the abdominal pain the symptoms and findings were suggestive of intestinal obstruction. Abdominal tenderness and rigidity were present, most marked in the right iliac fossa. Rectal and vaginal examinations showed tenderness in the right fornix, with apparent thickening. An immediate laparotomy was done, disclosing an obstruction the site of which was found to be in the right pelvic cavity where a coil of terminal ileum was found to be strangulated through a hole in the broad ligament.

**STRUSON'S CASE.** The patient, aged 30 years, a nullipara, was admitted to the hospital in an almost moribund condition. It was learned that she had been ill for 4 days with pain and tenderness of sudden onset, in the lower abdomen. She had vomited only once. An enema had been ineffectual. There was generalized abdominal tenderness, more marked, however, above Poupart's ligament on the right side. Vaginal examination was essentially negative. At operation considerable brown, foul fluid escaped and coils of gangrenous intestine presented themselves. At this time the patient died. After the incision was enlarged the greater portion of the small intestine and its mesentery were found strangulated through an opening in the right broad ligament.

**PEMBERTON'S AND SACKER'S CASE 1.** Ten days after a Baldy-Webster operation the patient, aged 30 years, experienced severe colicky-like pains in the lower abdomen followed by vomiting. Pelvic examination revealed a sausage-shaped mass on the left side. A diagnosis of incarcerated intra-abdominal hernia was made and at laparotomy from 30 to 35 centimeters of small bowel were found to be caught in the hole made for the round ligament on the left side of the uterus in the broad ligament. After the bowel was withdrawn, the left tube and ovary were removed and the left broad ligament incised. An anastomosis was required but the patient made a nice recovery.

**PEMBERTON'S AND SACKER'S CASE 2.** At a myomectomy operation on this patient, aged 36 years, who had had a Baldy Webster operation 12 years previously the authors found bilateral openings in the broad ligament at the points where the round ligaments had been previously led through for the suspension.

**HERMANN'S CASE.** During the course of an oophorectomy for a pelvic tumor in an 18 year old nullipara, there was found accidentally a recess on each side of the uterus in the para-uterine fossa. On the posterior leaf of the left broad ligament there was an oval foramen which allowed the passage of the finger for a depth of 5 centimeters in the anterior cul-de-sac. In a similar position on the right there was a smaller opening with a blind ending, which could be probed with a No. 7 Hegar dilator. The anterior surface of the broad ligament showed no change. The author concluded that probably the defects were congenital in origin. There was no evidence of an old healed general or pelvic peritonitis.

**University of Chicago Clinics' CASE 1.** The patient was 60 years old, gravida v ili-para, menopause at age of 45 years. On admission (July 19, 1931) the patient presented the following complaints: (1) gradual, steadily increasing distention of the abdomen (2) definite gain in weight for the past 6 months (3) feeling of fullness after meals and (4) constipation. The entire past history revealed no noteworthy facts, save that one sister died from cancer of the uterus. On physical examination the only important findings were abdominal. There was a large round mass occupying almost the entire abdomen and bulging in the flanks. A definite fluid wave was present. There was also some tympanites in the flanks, but the remainder of the abdomen was dull to percussion. There was no tenderness. The veins in the abdominal wall were slightly enlarged. On pelvic examination the cervix was found to lie in the midline and pointed back toward the sacrum. The uterus was found to be small and atrophic, anterior and freely movable. A soft, fluctuant bulging in the uterovesical pouch was noted. Tapping the abdominal mass gave a fluid impulse to this bulging. There were no unusual findings concerning the adnexa. The laboratory findings were negative, except for a slight secondary anemia. A pre-operative diagnosis of ovarian cyst was made.

A laparotomy was performed on July 19, which revealed a large non-adherent right ovarian cyst, filling the entire abdomen. There was a small hole in the right mesosalpinx. The right ovary was small and sclerotic. On further inspection of the pelvis an aperture in the right broad ligament without hernia of the bowel, superior and lateral to the utero-ovarian ligament near the ovary i.e. in the mesosalpinx, was noted. The right adnexa were removed *in toto* and the raw surfaces peritonized. Aside from a low-grade fever reaching a peak at 100 degrees F. on the third day the convalescence was entirely uneventful. The patient was discharged on August 1.

**Pathologic report.** The specimen (Fig. 1) consisted of ovary with its tube and mesosalpinx attached. The ovarian ligament could be seen at the lower border of the



mesosalphix, coursing upward and laterally toward the ovary. An aperture was found in the central portion of the mesosalphix, measuring 3.5 by 3.5 centimeters. The edges of this opening were thin and smooth, with no evidence of recent trauma.

**University of Chicago Clinics Case.** The patient, aged 25 years, gravida III, l-para, was admitted to the Chicago Lying-in Hospital on November 13, 1932, at term, with the following history. She had had two previous cesarean sections at this hospital for dystocia—November 1, 1923, and April 18, 1931, respectively. She had a postmenstrual pelvis with a conjugate diameter of 9.4 centimeters. On the first admission the low cervical cesarean section followed a 14 hour test of labor during the greater part of which a midwife had been in attendance. In neither operation did the intestines receive any manipulation. On both occasions mild infections had occurred superficially in the lower angle of the wound. There was no history of bowel distress of any nature.

On March 15, 1932, an elective low cervical cesarean section, with sterilization, was done. During the course of the operation, after the closure of the uterine wound, the following hernia was discovered in the left broad ligament.

A considerable portion of large bowel and a small portion of omentum were noted in the anterior portion of the left pelvis. This area was investigated and it was found that the bowel had herniated through a pouch in the posterior sheath of the left broad ligament, which was located inferior to the tube, round ligament, and ligamentum proprium ovarii. The anterior wall of this pouch was composed of the peritoneum of the anterior left broad ligament and bladder peritoneum. The incision through the bladder peritoneum had exposed this herniated bowel. The opening of the pouch on the posterior surface of the broad ligament was about 4 by 5 centimeters, elliptical in shape and near the uterus. Gentle traction easily released the bowel, which showed no sign of constriction or adhesions. Dr. M. Edmund Davis employed a unique method of closure of the defect, as shown in the accompanying illustrations (Figs. 2 and 3). After the pouch in the posterior sheath of the broad ligament was closed by interrupted sutures, the round ligament was plicated by similar sutures to the edge of the uterus, supporting the repaired defect.

The convalescence was entirely normal, save for a mild wound infection similar to those of the two previous cesarean sections. At 6 weeks the patient had made an excellent recovery and was entirely free of complaints.

#### SUMMARY

1. This form of internal hernia is rare and probably is the least common of the intra-abdominal strangulated hernias. Only 13 authentic cases of strangulation through defects of the broad ligament were found in the literature, and only 2 cases were noted in which such defects were present but unassociated with strangulation.

2. This condition, however, probably is more common than the reported cases would indicate.

3. In cases in which pouches were the offending defects, congenital anomalies may be strongly suspected. Distention and distortion of the broad ligament from pregnancy or pelvic tumors seem the most likely factors in the production of fenestration in that structure. Older multiparae are almost exclusively affected, although nulliparae

women are not immune. The Baky Webster operation may be looked upon as an etiological factor.

4. The anomalies occur without strangulation. Two such cases are reported.

5. Although the condition has never been diagnosed before operation, it might conceivably be done.

6. The treatment is comparatively simple. The defect should be enlarged or incised to liberate the bowel, and then carefully closed by sutures. Removal of the adnexa may be preferable if the patient is an elderly woman or if the circulation is seriously impaired. The round ligament may be utilized to give a firmer repair of an aperture.

7. The prognosis as to life seems good, if early diagnosis of the obstruction is made and intervention takes place. The morbidity however in this series was high.

Since this report was completed, J. C. Mason and Walter Atkinson have reported a case of hernia of the ovary into a defect in the broad ligament. This is unique, as it is the only record of any other viscus than the bowel to become thus strangulated.

Since this time there also has come to our attention in the University Clinics, another very interesting case. This patient had had a Baky-Webster operation on June 24, 1933 and returned on July 24, 1933 with a complete obstruction of 4 days' duration. There were two loops of small intestine held by adhesions to the site of the plication of the round ligaments on the posterior wall of the uterus. There was, however, no defect in the broad ligament into which the bowel might have been incarcerated.

I wish to express my thanks to Dr. Fred L. Adair for the privilege of reporting the first case and for other courtesies he has obligingly extended in the preparation of this report. I am also indebted to Dr. J. B. DeLee for his kind assistance and permission to report the second case.

#### BIBLIOGRAPHY

1. BAX. Strangulated hernia of the small intestine through the left broad ligament. *South. Texas M. Rec.*, 1920, xiv, 5.
2. BARNARD, C. H. Contributions to Abdominal Surgery, 1910.
3. COOPER, R. W. Strangulation of the small intestine. *Australasian & New Zealand J. Surg.*, 1931, I, 325.
4. COMLAK, S. Strangulated hernia of broad ligament. *Brit. M. J.*, 1930, I, 950.
5. DORRAN, W. Ectomycosis. Hernia into the broad ligament. *Brit. M. J.*, 1928, II, 528.
6. DULLER, C. W. Proportional hernia. *J. Am. M. Ass.*, 1839, xiii, 557.
7. DUNK, LOUIS. Hernia in broad ligament from clinical point of view. *Surg. Gynec. & Obst.*, 1926, xlii, 395.

8. EVE, FREDERICK S. Case of strangulated hernia into the fossa intersigmoides. Brit. M. J., 1885 1 1195.
9. FAOGE, C. H. Two cases of strangulated retroperitoneal hernia into pouches of the broad ligament. Brit. J. Surg., 1918, v 694.
10. HERMANN E. Aus dem Krankenhaus der Wiener Kaufmannschaft Recessus Parauterinus. Zentralbl. f. Gynæk. 1925 xlix, 63.
11. JAMES, ROBERT. Two cases of intestinal obstruction due to strangulation of a loop of small intestine into an opening of the left broad ligament. Brit. J. Surg., 1929-1930, xvii, 333.
12. JUNG JAMES R. Mesenteric defects with especial reference to their etiology and report of a rare case of colonic obstruction. Surg. Gynec. & Obst., 1929 xlviii, 264.
13. KOSTAKOVICH, K. L'Evolution du Segment lateral du Ligament Large. J. d'anat. d'histol. et d'embryol. 1930, xi-xii, 77.
14. LAWRENCE, SIR WILLIAM. Cited by F. S. Eve. A Treatise on Hernia. p. 630 Bremen, 1818.
15. MARSON J. C., and ATKINSON W. Proc. Staff Meet. Mayo Clin., 1933 viii, 293.
16. MOYNTHAM SIR HERULEY On Retroperitoneal Hernia, 1906
17. PEMBERTON, JOHN, and SAGER, WARREN W. Intestinal obstruction following the Webster Baldy operation for retroversion. Surg. Clin. N. America 1929 ix, 203.
18. PIDDOCK, B. H. Intestinal obstruction. Brit. M. J. 1924, i, 369.
19. QUAIN Case of internal strangulation of a large portion of the ileum. Trans. Path. Soc., Lond., 1861 xli, 103.
20. RICHARDSON, EDWARD P. Intestinal obstruction following Baldy Webster operation for retroversion report of case. Surg., Gynec. & Obst. 1920, xcxi, 90.
21. SIMMONS CHESTER M. Hernia strangulated through the broad ligament. Am. J. Obst. & Gynec. 1928 xv 251.
22. TREVES FREDERICK. The anatomy of the intestinal canal and peritoneum in man. Brit. M. J. 1885 i, 415 470, 527 580.

## CARCINOMA OF THE BUCCAL MUCOSA

AN ANALYSIS OF THE CASES OBSERVED AT THE MASSACHUSETTS GENERAL HOSPITAL IN THE THREE YEAR PERIOD 1924-1926

GRANTLEY W. TAYLOR, M.D. F.A.C.S. BOSTON

SIMMONS has previously reported reviews of the cases of cancer of the buccal mucosa observed at the Massachusetts General Hospital and the Collis P. Huntington Memorial Hospital for the two 3 year periods 1918-1920 and 1921-1924.<sup>1</sup> Recently Lund<sup>2</sup> has made a careful end-result study of the cases observed at the Collis P. Huntington Memorial Hospital for the 9 year period 1918-26.

The present communication is a study of the cases observed at the Massachusetts General Hospital during the 3 year period 1924-1926. Many of these cases were also seen at the Collis P. Huntington Memorial Hospital and were therefore included in Lund's study.

The material comprises all cases of cancer of the buccal mucosa, including tongue, floor of mouth, cheek, palate, jaw, and tonsils, which were admitted to the Massachusetts General Hospital or to the Phillips House during the 3 year period.

TABLE I.—CASES AVAILABLE FOR END-RESULT STUDY

Number of cases	83
Cases included in previous series	
Untraced Massachusetts General Hospital	1
Untraced Phillips House	1
Died without recurrence in less than 5 years	1
Living less than 5 years since last treatment	
Pathological specimen lost	
Total exclusions	4
Available for end result study	79

Of these 83 cases, 74 were primary cases and 9 were recurrent cases. The regional distribution of the cases is shown in Table II.

TABLE II.—REGIONAL DISTRIBUTION

	Primary	Recurrent	Total
Tongue	29		29
Cheek			3
Floor	6		7
Palate	9	1	10
Lower jaw	12		12
Upper jaw	3		3
Tonsil	2		2
Total	71	9	80

Simmons, C. C. Cancer of the mouth. *Burg. Gynec. & Obst.* 1924, 13(2), 377-382. Cancer of the buccal mucosa. *Ann. Surg.* 1926, 82(1), 66-69. The treatment of oral cancer. *Ann. J. Roentgenol.* 1917, 10(1), 8-11.

Lund, C. C. and Mattson, H. M. Carcinoma of the buccal mucosa. *New England J. Med.* 1923, 188(1), 773-781.

Multiple tumors were present in 2 cases in this series at the time of operation. Recurrences were observed in 3 cases, 2 of whom died within the 5 year follow-up period without evidence of recurrence of the original lesion and the remaining patient is living 7 years after his original operation and 18 months after operation for the recurrence.

**Etiology.** Eight of the 83 cases occurred in females. Syphilis was present by clinical or serological evidence in 12 cases of 60 in which data are available. The carcinoma involved the tongue in 9 of these cases. Three patients were recorded as non-users of tobacco out of 63 in which data are available. Twenty of these 63 patients chewed tobacco, and 4 of these presented carcinoma of the inside of the cheek. Leucoplakia was present in 22 cases. The teeth were described as good in 2 cases, there was no record of the teeth in 20 cases, and the remainder presented extensive caries or were edentulous. Trauma from carious teeth or ill fitting dentures seemed to be directly antecedent to the development of cancer in 21 cases, including 5 of the women in the series.

**Duration of disease.** Definite data in regard to the lapse of time between the onset of the disease and the first consultation are available in 78 cases. These figures are not strictly comparable to Simmons's series because his tables include also cases treated exclusively at the Huntington Memorial Hospital, where the clinical material includes a greater proportion of late and inoperable cases.

TABLE III.—DELAY FIRST SYMPTOM TO FIRST CONSULTATION

	1924-1926 Per cent	(Simmons) 1921-1924 Per cent	(Simmons) 1918-1920 Per cent
Less than 1 month	41	64	60
One to 2 months	38	1	27
Over 2 months	21	35	13

The distribution coincides strikingly with Simmons's earlier series, but unfortunately fails to confirm the improvement that he noted in his later series.

The pre-operative duration of the cases in which cure was effected averaged 5 months, as

compared with 6 months in Simmons's series. The average pre-operative duration of the cases with metastatic lymph node involvement when first examined was 4.5 months. These figures emphasize the fact that cures are effected mainly in slowly growing cancers, and that cervical node metastases are established at an early date in tumors having a tendency to metastasize.

**Definition of terms employed Cure** The term "cure" is used to designate a patient living without evidence of local or metastatic recurrent disease 5 or more years after the last treatment no case has been included without a positive microscopic diagnosis of cancer.

**Radical operation** is here used to designate any operation which in addition to removal of the local process involved removal of cervical lymph nodes as well. Ideally the radical neck dissection should remove all the lymph node bearing tissue from the clavicle to the mastoid process, and from the anterior border of the trapezius to the mid line. This operation involves removal of the sternomastoid muscle and the internal jugular vein as well. It should probably also include some attack on the lymph node areas of the opposite side of the neck, since many of these growths metastasize freely to both sides of the neck. However in this series many of the neck dissections were very much less radical than this ideal operation, often involving removal of the contents of the submaxillary area alone.

**Local operation** is here used to designate any operative procedure involving removal of the local growth without any attack on the cervical lymph nodes.

**Results of operative treatment** Of 83 cases in this series, 66 were treated by operation, of whom 31, or 32 per cent, were living and apparently free from disease 5 or more years after their last

treatment. Four of the recurrent cases were treated by radical operation and they are included here.

In 19 cases evidence of lymph node metastasis was shown on pathological examination. Four of these (21 per cent) are included as cures in Table IV. Clinical estimate of lymph node involvement was extremely inaccurate. Thus positive pathological nodes were found in 5 of 20 cases in which the patients' lymph nodes were not demonstrable clinically. On the other hand, clinically enlarged nodes were found in 24 cases but they proved to be involved in cancer in only 14 cases by microscopic examination. It is noteworthy that in only 1 of the 4 cured cases with positive pathological metastasis was clinical evidence of metastasis demonstrated. This fallibility of clinical estimate is in large part responsible for the rather low percentage of cures following local operations. In many instances the general condition of the patient does not warrant radical neck dissection. However, Table V demonstrates the desirability of neck dissection whenever it is possible.

TABLE V—NECK DISSECTION

	Number	Cures	Per cent
Local operations	33	0	0
Radical operations (nodes not involved)	11	4	36
Radical operations (nodes involved)	10	4	40
Radical operations—total	21	8	38

Operative fatalities accounted for the death of 5 patients in this operative series. These deaths followed the local intra-oral operations and in no case followed neck dissection.

TABLE VI—CAUSES OF DEATH IN FIVE FATALITIES

Location of Disease	Operation	Cause of death
Tongue	Excision	Pneumonia—streptococcus septicemia
Cheek	Excision	Embolism
Tongue	Excision	Lung abscess—pyelitis pericarditis
Lower jaw	Resection	Erysipelas streptococcus septicemia
Tongue	Excision	Pneumonia

**Radiation treatment** About half of the patients in the operative series received some radiation therapy, usually in the form of postoperative prophylactic X ray therapy. This consisted as a rule in two or three treatments given a few days after operation over the neck area. Ten of the patients who had some form of radiation in addition to operation are still living. Careful analysis of the treatment they received makes it appear doubtful whether the radiation influenced the outcome in any way. In many of the inoperable cases and most of the recurrent cases the patients were treated with radiation, in the form of radon

TABLE IV—RESULTS OF OPERATIVE TREATMENT

	Local operation	Cures	Radical operation	Cures	All operable cases	Cures	Per cent
Tongue	9	3	13	6	22	9	40
Cheek	8	4	5	0	13	4	30
Flap		1	4	1	5	2	40
Palate	5	3	4	2	9	5	55
Lower jaw	5	1	7	3	12	4	33
Upper jaw	1	0	0	0	1	0	0
Throat	1	0	1	1	2	1	50
Total	33	12 (36%)	34	13 (38%)	66	21 (32%)	

seed implants to the local process and X-ray therapy to the neck. None of the cases treated exclusively with radiation is alive. It is undoubtedly true that radiation was a desirable palliative in the series, and that lives were prolonged by its use but it seems equally true that there were no cures due to radiation as employed in this group.

*Pathological index of malignancy* Pathological specimens were graded according to the degree of malignancy in 51 instances. Two patients presented multiple lesions of different grades of malignancy. There appears to be a very close correlation between the grade of malignancy and the prognosis.

TABLE VII.—INDEX OF MALIGNANCY

	Cases	Cures	Per cent
Grade I	4	2	50
Grade II			
Grade III	3		0

If the cases with proved cervical metastases are analyzed as to the degree of malignancy it is found that 3 cases were Grade I and 4 were

Grade II. Two cases in each group were cured by operation. Thus a low grade of malignancy of the primary growth does not carry any exemption from cervical node metastasis. The curability of cases with low grades of malignancy should encourage more frequent neck dissection in this group. On the other hand, if the grade of malignancy of the primary growth is high, it is doubtful if neck dissection is worth while.

#### SUMMARY

There were 109 cases of cancer of the buccal mucosa admitted to the Massachusetts General Hospital in the years 1914-1926. End-results are known in 83 patients of whom 66 were operable. Five year cures were obtained in 21 cases (32 per cent). It is unlikely that radiation contributed to the cures in this series. Radiation seems of definite benefit as a palliative in recurrent and inoperable cases. There seems to be definite correlation between the grade of malignancy and the prognosis.

# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.  
ALLAN B. KARAVEL, M.D.  
LOYAL DAVIS, M.D.

Managing Editor  
Associate Editor  
Associate Editor

DONALD C. BALFOUR, M.D. Associate, Editorial Staff

MAY 1934

### THE STATUS OF "BILLROTH NO 1" IN THE SURGERY OF STOMACH AND DUODENUM

THE restoration of gastro-intestinal continuity following gastric resection always is a problem to the surgeon. Whatever the method used, there are certain general objectives which must be attained to as great an extent as possible, the most important of these are safety of operation, good function and protection against recurrence of the disease for which the operation was done.

The Billroth II principle has deservedly won wide popularity and in the present state of knowledge probably will be the usual method of choice for restoring continuity after resection. In the development of the various modifications of the Billroth II procedure, however, the fact has been somewhat overlooked, in this country at least, that the Billroth I procedure, by which gastro-intestinal continuity is re-established by uniting the stomach to the duodenum by end-to-end anastomosis has become an operation which, because of greater skill both in technique and selection of cases, under certain circumstances

is superior to those procedures by which the stomach is united to the jejunum.

The assumption that physiological function more nearly approximates normal after the Billroth I procedure than following those operations which unite stomach to jejunum is correct at least in theory. Horsley and others have drawn attention to the advantage of the Billroth I method from this standpoint, and the suggestion of Horsley that continuity be re-established by approximation of the lesser curvature of the stomach to the superior border of the duodenum, rather than the greater curvature to the inferior border of the duodenum is an example of the physiological approach to such an operation. In clinical experience however, it has been shown that satisfactory function from every standpoint may be obtained by those operations which unite stomach and jejunum, and since a comparative study of functional end results shows no superiority in this respect of the Billroth I over the Billroth II operation, the chief reason for selecting the former method is the presence of certain conditions that apparently give rise to some objection to uniting stomach to jejunum.

Gastric resection has become an established procedure for both gastric and duodenal ulcer, but it is only when this operation is wisely applied that the best results are obtained, both in respect to cure of the disease and low mortality rate. In the surgical treatment of gastric ulcers, it has been conclusively shown, that the danger of jejunal ulceration, following anastomosis of the stomach to the jejunum, whether or not gastric resection has been done is so insignificant that any method

of restoring continuity in order to avoid the use of the jejunum has no particular purpose. Therefore, there is no advantage on this score of the Billroth I operation in cases of gastric ulcer and since the functional results with the Billroth II procedure, or with one of its modifications, are so excellent, this latter type of operation should be looked on as the operation of choice in these cases.

For duodenal ulcer gastric resection occasionally is clearly indicated although its place in this disease is not well defined as yet because so many factors must be weighed before an operation of such extent is warranted. There is one group of cases, however in which partial duodenectomy and gastric resection is the operation of choice namely those in which serious and repeated hemorrhages have been the sole reason for carrying out surgical treatment. It is only in a certain percentage of this group however that resection is justifiable because of the risk entailed in dissecting out and removing that portion of the duodenum in which the lesion or lesions, have developed. It is exceedingly fortunate that inflammatory processes of the duodenum as a rule are confined to an accessible portion of the bowel and increasing experience shows that even in apparently irremovable lesions, the segment often may be safely mobilized and removed. When the Billroth I operation can be done with safety in so far as the mechanics of the procedure are concerned restoration of the continuity of stomach and duodenum has definite superiority for the reason that with gastrojejunostomy there is the possibility small though it is of jejunal ulceration whether or not resection has been done. Again while the incidence of recurrence of ulceration after the Billroth I operation is low as has been established by European observers, there is the added advantage that if it does occur, further surgical treat-

ment is not so difficult as it becomes when the jejunum is the site of the recurrence.

In gastric carcinoma the Billroth I operation has very definite disadvantages in spite of the fact that the operation often can be performed more readily for this disease than for any other condition since the duodenum usually is mobile and is not involved in any inflammatory process. Experience has shown however that if recurrence of malignancy does take place it may either by directly involving the anastomosis or indirectly from extragastric extension produce an obstruction which in some instances has required secondary operation. On the other hand, when the Billroth II procedure is used for gastric carcinoma, should recurrence take place in the retroduodenal lymph nodes and tissues, there is very rarely any interference with gastric function and the patient is spared the distress of gastric obstruction.

Probably the most important circumstances under which the Billroth I operation can be applied are represented by those cases in which recurrence of ulceration or mechanical difficulty has developed following gastrojejunostomy either with or without resection. In the surgical care of jejunal ulceration, after disconnection of the gastrojejunal stoma, which must always be done, the advantages of re-establishment of gastroduodenal continuity rather than gastrojejunal continuity are readily apparent. This advantage is secured when only gastro-enterostomy has been previously done for then the original lesion in the duodenum usually can be excised satisfactorily and the pyloric outlet reconstructed. If partial gastric and duodenal resection is indicated after disconnecting the gastro-enteric stoma, the remaining portion of the stomach can be re-united to the duodenum if necessary to the second portion of the duodenum, below the site of scarring of the pri-

mary lesion. The more serious and complicated the situation, such a situation as is seen for example in those cases in which because of repeated recurrence of ulceration repeated resections have been done with utilization in each instance of the jejunum, the greater becomes the advantage of re-uniting stomach to duodenum. The spectacular results which follow such an operation under these circumstances are a striking example of what modern surgery may accomplish in the solution of difficult surgical problems.

There occasionally also are encountered those cases in which because of malfunction of a posterior gastro-enteric stoma, second posterior or anterior gastro-enterostomy has been done without much, if any relief of stasis. In such cases gastric dilatation and atony have been found so marked that the best procedure is disconnection of both gastro-enteric stomas, resection of the portion of the stomach on which they had been made and anastomosis of the remainder of the stomach to the duodenum.

Although the advantages of the Billroth I operation are clearly apparent under certain circumstances, and although it has been shown that when properly selected it is an operation that is as safe as any other method of resection, it should be emphasized that technically this procedure usually is more difficult, or at least invites more risk than the Billroth II procedure or any of its modifications. There are, however, many variations in the method of its accomplishment to avoid these difficulties and risks, the more important of which are closure of a portion of the end of the stomach before the anastomosis is made, puckering of the end of the stomach to decrease its perimeter, splitting the anterior wall of the duodenum to increase its perimeter and finally the very important method of utilizing the second portion of the duodenum

as described by Tinney and von Haberer.

The results of the Billroth I operation are so gratifying that in the solution of some especially complicated problems met in gastric surgery the operation is worthy of more extensive employment in America than is accorded it at present. DONALD C. BALFOUR.

## BEGIN AT HOME

EVERYONE who has made a study of the cancer problem appears to agree that cancer can be cured in a very high percentage of cases if diagnosed and treated in an early stage. Most cancers are not seen early. However the histories of patients with far advanced lesions indicate that in many instances the delay in diagnosis must be charged to the medical attendant who failed to make an adequate examination or to appreciate the significance of suggestive symptoms or lesions. Such observations should impress us with the importance of intensive education of the medical profession in our attack on the cancer problem, we must begin at home.

Early cancer does not produce symptoms and early diagnosis is possible only through careful periodic medical examinations. While certain lesions deep within the body may not be found by any of our present methods until well advanced, there is little excuse for failure of a physician to diagnose a lesion of the tongue, lip, breast, cervix or skin during a carefully made physical examination. Most cancers on the accessible portions of the body can be cured if diagnosed early and then properly treated. Realization of this ideal depends on the development of careful periodic health examinations.

Medical practice is gradually changing and it is now recognized that the physician of the future will devote much more of his efforts



toward keeping his clientele healthy. Thus far there is no standard to guide us and everyone has a different idea regarding the minimum requirements which may make a periodic health examination worth while. Obviously standards must be based on experience. An adequate physical examination requires that clothing be removed. There should be no difference of opinion regarding the value of the common tests such as palpation, auscultation, percussion and inspection including cervix uteri. Blood pressure, weight and urinalysis are commonly accepted by insurance companies as an important part of a medical examination and these tests should become a part of every office record. Different opinions will be found regarding the routine use of other laboratory tests but it is believed that a complete blood count is desirable and a determination of the basal metabolic rate is important for a considerable portion of the population. If used routinely all of these tests could be furnished at a relatively low cost to each patient. When it comes to special examinations which require con-

siderable time and expensive equipment the cost appears to be too great for consideration of routine use in a periodic medical examination and for the present these should be limited to the individuals who are found to have symptoms or physical findings which indicate the need for special tests. It is realized that even with all of our present methods perfect diagnosis is not possible.

"Begin at home" should be the slogan of the medical profession in a campaign to educate the laity to appreciate the value of periodic examinations. Begin at home by preparing ourselves to make a type of examination which will be of real value to the families who look to us for medical guidance. Begin at home by having regular examinations of ourselves and our immediate families. How many of us have been doing this in the past? Gradually we will be able to demonstrate the value of the periodic medical examinations to others and incidentally many of the profession will have a variety of conditions diagnosed before they become serious. Let us begin at home.

CARL HENRY DAVIS.





PAUL Y TOPPER  
1858-1928

# MASTER SURGEONS OF AMERICA

---

PAUL YOER TUPPER

AS one of the youngest in the large family of the Rev Henry Allen and Nancy (Boyce) Tupper and of evident Scotch Irish English stock Paul Yoer Tupper was born in Washington Georgia on March 1 1858 His father was a Baptist minister whose calling took him also to South Carolina and to Richmond Virginia In the latter city the adolescent young man attended Norwood High School and Richmond College

In 1878 he matriculated in Hospital Medical College at Louisville Kentucky (later the Medical Department of the University of Louisville) from which school he graduated in 1880 Throughout the following year he functioned as interne in the Louisville City Hospital, then in the same capacity in the Forest Hill Lying In Hospital Resigning from the latter and also returning a commission in the Medical Corps of the United States Navy he came to St Louis in 1881

Soon after finding a location for an office he was honored by the late Dr L Ch Boislaniere who called to welcome a newcomer Probably through the friendship of Dr Boislaniere, he became assistant to Prof Elisha H Gregory, who was then at the height of his eminent career as a surgeon As chief surgeon of St Louis Mullanphy Hospital Dr Gregory had a vast amount of clinical material at his command which gave the young Tupper exceptional opportunity for thorough training in clinical surgery The association with the brilliant Dr Norman Bruce Carson also surgeon to Mullanphy Hospital was a considerable additional advantage During these years he divided his time between the services of his chief and a growing private practice still he took the advice of Dr Gregory and spent much time in the dissecting room In 1887 he was appointed instructor in practical anatomy at the St. Louis Medical College, and was promoted to professor of descriptive anatomy in 1890 Nine years later the St Louis Medical College united with the Missouri Medical College and became the Medical School of Washington University Dr Tupper held the chair of applied anatomy and operative surgery in this noted school until he voluntarily retired in 1923 as emeritus professor of surgery

During his more mature years he endeavored to confine his professional activity to patients at the Missouri Baptist Sanitarium and St Luke's Hospital He was surgeon to both of these institutions and honorary consulting surgeon

to the Jewish, Bethesda and St. John's Hospitals. He was the foremost and most dependable surgical consultant of the middle section of the Mississippi Valley conservatively cautious or boldly radical according to conditions. His calm and clear judgment was a combination of accumulated scientific facts and that perfect behavior in the sick room which is Sir William Osler's *Æquanimitas*. The latter's keen sense of humor also found almost an exact counterpart in the ever ready kind pleasantry of Dr. Tupper. Patients and colleagues soon felt that he could descend or rise to the level of any honest and worthy member of the human race. Nevertheless with all his graceful courtesy toward decency and uprightness as becomes a gentleman of typical southern culture he never tolerated rude discourtesy or even a semblance of dishonest dealings. Then as a rule perhaps following the wisdom and example of Socrates his criticism or anger was expressed by sparing of speech or absolute silence.

A decade or so before the turn of the century it was customary for recognized surgeons in St. Louis to attend some patients nightly belonging to a general practitioner. Dr. Tupper was among the first to limit his practice to distinctly surgical cases. He attracted promising young men who were encouraged and inspired by his outstanding surgical ability and his sympathetic cheerfulness toward all mankind. As such a man he was actually immune to malpractice suits.

With him a major operation was a sacred trust. He always considered the patient's welfare and never spared himself. Each evening he would make the rounds of the hospitals. On February 1, 1928, shortly after returning from this regular trip and when preparing to retire for the night, he suddenly exchanged life for death, having been privileged to remain actively at work until the very end. A blessed reward for a true aristocrat!

In 1890 he was married to Miss Marie Papin Moses. His widow and one son, Mr. Gregory Tupper, survived him.

He wrote a moderate number of papers and other articles upon various anatomical and surgical subjects, but modestly withheld much of his valuable experience from publishers and printers. While this might be deemed a fault it was certainly counterbalanced by his many singularly noble attributes. However well his wide scientific knowledge and operative skill were recognized by his pupils, associates, and patients, he failed to attain a well merited prominence, because he wrote little. This, however, was of his own choosing. He also had a peculiar knack of avoiding office in local and general medical and surgical organizations. Still when an appointment came to him he did more than his duty.

Unostentatious devotion to professional service, coupled with an extremely rational estimate of all newer developments upon a background of thoroughly established fundamental principles and studiously acquired ability, embodies the highest virtues within the domain of the healing art. Measured by this yardstick, Dr. Paul Y. Tupper was an ideal surgeon.      ROBERT E. SCHLUETER.

# EARLY AMERICAN HOSPITALS

## A SHORT HISTORY OF THE MASSACHUSETTS GENERAL HOSPITAL

JAMES C. WHITE M.D. F.A.C.S. BOSTON

From the Surgical Services of The Massachusetts General Hospital

IN 1810 Massachusetts possessed no hospital for the sick or asylum for the insane although such institutions already existed in Philadelphia and New York. It was the inhuman treatment of the insane rather than the inadequate care of the sick, which led the Rev. John Bartlett, at that time Chaplain of the Almshouse at Boston, to write fifteen to twenty five billets addressed to some of the wealthiest and most respectable gentlemen of Boston requesting them to meet to take into consideration the importance of adopting some measures for the establishment of a Hospital for the Insane. Among these gentlemen were Drs. John C. Warren and James Jackson who in August, 1810 sent out a circular letter which has come to be regarded as the corner stone of this institution. The letter is too long to be reproduced in full, yet some of its phrases are too good not to quote

Boston, August 30 1810.

Sir—It has appeared very desirable to a number of respectable gentlemen, that a hospital for the reception of lunatics and other sick persons should be established in this town. It is unnecessary to urge the truth and importance of these sentiments to those who are already in the habit of cherishing them,—to those who indulge in the true luxury of wealth the pleasures of charity.

The relief to be afforded to the poor in a country as rich as ours, should perhaps be measured only by their necessities. A man may have lodging, but it is deficient in all those advantages which are requisite to the sick. Above all, he suffers from the want of that first requisite in sickness, a kind and skilful nurse. In a well regulated hospital, the sick would find a comfortable lodging in a duly tempered atmosphere would receive the food best suited to their various situations and would be attended by kind and discreet nurses, under the directions of a physician.

In addition to what has already been stated, there are a number of collateral advantages that would attend the establishment of a hospital in this place. These are the facilities for acquiring knowledge, which it would give to the students of the medical school established in this town. A hospital is an institution absolutely essential to a medical school and one which would afford relief and comfort to

<sup>1</sup> This half of the original plan was carried out by the erection of the McLean Asylum across the Charles River in Bostonville. In 1805 the development of the railroads rendered this originally attractive site unworkable and necessitated the building of the present institution in Waverly.

thousands of the sick and miserable. On what other objects can the superfluities of the rich be so well bestowed?

Hospitals are found in all the Christian cities of the Old World and our large cities of the Middle States have institutions of this sort which do great honor to the liberality and benevolence of their founders. We flatter ourselves that in this respect, as in all others, Boston may ere long assert her claim to equal praise.

We are sir very respectfully yours, your obedient servants,

James Jackson  
John C. Warren

The spirit of this letter emphasizing the need for a hospital, careful nursing of the sick, and the teaching value of such an institution shows the foresight of these two men who were to become its first physician and surgeon and who directed its growth for a period of 20 and 36 years, respectively.

In the following February (1811) a charter was obtained from the State Legislature and also a grant of land valued at about forty thousand dollars, on the condition that one hundred thousand dollars more should be raised by individual subscription. This sum was not secured until 1817. In that same year a tract of land fronting on the Charles River was purchased for twenty thousand dollars and Charles Bulfinch, the leading architect of the city was employed to visit the hospitals of New York and Philadelphia. Bulfinch's design for a building was accepted by the trustees in the following year and the corner stone laid with oratory befitting the occasion on the fourth of July 1818. The original building was made of granite cut by the convicts in the State Prison and its exterior was substantially the same as it appears today except that the east and west wings were only half their present length and the latter was flanked by the mud flats on the river's edge.

As originally designed the Bulfinch building was capable of accommodating 60 bed patients in four wards which were situated in the wings. The ground floor was taken up with an accident room which served also as a dispensary for out-patients the laundry, and a kitchen with great open fire

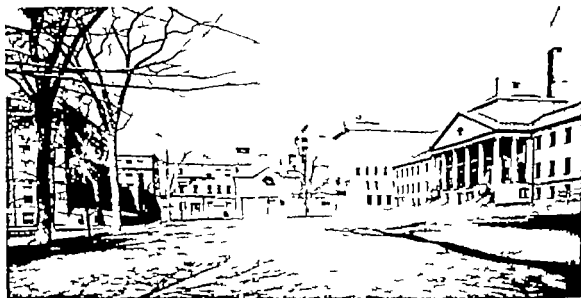


Fig. 1. The Massachusetts General Hospital viewed from the State House dome in 1850 and from a corner of the yard at the present day. The original Bulfinch building shows little change. All the recent additions to the hospital in the background have been constructed on land which has been reclaimed from the Charles River. In the early picture the McLean Hospital for the Insane is shown on the opposite side of the river. This site has now been abandoned, due to the encroachment of the railroad yards and the growth of the city.

places and brick ovens. The operating room was under the central dome and beneath it offices and a few private rooms. The stuffy attic sheltered the nurses.

The doors of the hospital opened to its first patient on September 3, 1821—a man with tertiary syphilis, necrosis of the nasal bones, and suffering primarily from overdoses of mercury. After lingering on the wards for 8 months with continuous diarrhoea and stomatitis, he died of an ulcerated larynx. The first major surgical case

required an operation for stone in the bladder. In preparation for this operation the patient was given 120 minims of laudanum by rectum (equivalent to nearly  $1\frac{1}{4}$  grains of morphine); his hands and feet were then tied together and two assistants detailed to hold his shoulders. The calculus was extracted through a perineal incision. It is recorded that although the operation lasted only a few minutes, the patient expressed great pain in every part." No wonder that Mr. Peppys recorded in his diary each anniversary of the occa-



Fig. 1 Preparations for one of the earliest operations under ether anesthesia.

W T G Morton  
G Hayward S Parkman  
S D Townsend John C Warren  
J Mason Warren

There is some question whether the individual at the head of the table is Dr. Morton or another individual impersonating him.

sion on which he was cut for the stone and that he celebrated it with wine and playing on the flageolet!

The history of the hospital during its first 25 years is one of slow but steady growth. After the initial grant of forty thousand dollars from the state its financial support came entirely from private sources. Only a third of its patients were of the paying class and these contributed the modest sum of three dollars a week for board and nursing. No charge was made for medical care, a policy which has been adhered to ever since. Compared to present standards it is extraordinary to note the length of hospitalization of these early cases, an average period of 81 days. It is recorded that one girl remained in the wards for 5 years and 9 months. Considering these facts, it is not surprising that the original capacity of 60 beds soon became inadequate. This was increased to 150 beds in 1846 by doubling the length of the wings of the Bulfinch building.

In this same year came the discovery of the inhalation of sulphuric ether for the prevention of pain—a lucky coincidence for the increasing number of patients who were to be put to sleep on the operating table instead of being held there by stout leather straps and the arms of strong assistants.

As far back as 1795 a Dr. Thornton in England had advised a patient to inhale ether vapor for a painful condition of the breast. At this time and subsequently according to Beddoes, Dr. Thornton was in the habit of administering the vapor of ether to his patients. In Pereira's *Materna Medica* published in London in 1839 it was stated that the vapor of ether is inhaled in spasmodic asthma, chronic catarrh, whooping cough and to relieve the effects caused by the accidental inhalation of chlorine gas. These facts were well known to Dr. Charles T. Jackson, a Boston physician and chemist of great ability. He inhaled ether vapor on several occasions to obtain relief from the unpleasant effects of chlorine gas and once in 1841 inhaled a sufficient quantity to produce complete insensibility. He also entertained his classes in chemistry by its administration to students to the stage of mild intoxication and applied the liquid directly to numb the nerve in an aching carious tooth. He had however discovered nothing really new about the drug and it would seem that he had not the remotest conception of its universal importance as in the course of the next 5 years he never made any further experiments or took a single step to have it tested in a surgical operation. It remained for a dentist, Dr. William T. G. Morton to





Fig. 3 Hospital kitchen, 846.

utilize this previous knowledge and to develop a safe and practical method for prolonged complete etherization thereby realizing a dream of surgeons from the time of Hippocrates but one which few had ever expected to see fulfilled. It is interesting to note that only 7 years previously the great French surgeon, Velpeau, had written "To escape pain in surgical operations is a chimera which we are not permitted to look for in our day."

Dr Morton had been a student of Jackson's and formerly a partner of a Connecticut dentist whose name is famous for the early use of nitrous oxide—Dr Horace Wells. In July 1846 he practically gave up his dental practice and concentrated all his energies on the problem of producing insensibility to pain. Dr Jackson advised him to try "rectified sulphuric ether" rather than nitrous oxide, assured him of its safety and told him where he could purchase a supply of the chemically pure product but after this appears to have come to the conclusion that Morton was an unreliable character and refused to give him further assistance or backing. Morton tried his experiment first on a dog, next on himself and finally on September 30, extracted a tooth without pain. This led up to the successful demonstration on October 16 1846 in the old operating room under the dome of the Bulfinch Building. Morton administered the drug on a sea sponge in a glass inhaler to a patient with a tumor under the jaw. The surgeon who was ready to stake his

reputation in testing Morton's "Letheon" was John Collins Warren. At the end of the operation he answered Morton's critics with the words,

Gentlemen this is no humbug! The further trials, resection of a large tumor from the arm, and a few days later an amputation of the thigh, were equally successful. Thus it was demonstrated that ether could be used with safety to produce insensibility during any type of major surgical procedure. Within the first year of this discovery it was used in 132 operations in the hospital without a single accident.

It is difficult for us today to understand how any controversy could have arisen over the distribution of honors for this achievement and yet so bitter a dispute arose between the friends of Jackson and the defenders of Morton that in 1867 at the time of the erection of a monument to the discovery neither man's name was inscribed on the pedestal. Dr Jackson, because Morton had been a pupil of his and because he had suggested to him that he try chemically pure ether instead of nitrous oxide in his experiments, felt that he should have the chief credit for the discovery and claimed that he had in fact made it 4 years previously. The merits of the case were perhaps best summed up by Dr Jacob Bigelow who was then the leading physician on the hospital staff and president of the American Academy of Arts and Sciences.

In the case of Dr Jackson, if he did make the discovery in 1842, as asserted, he stands accountable for the man of

human misery which he has permitted his fellow-creatures to undergo from the time when he made his discovery to the time when Dr. Morton made his. In charity we prefer to believe that, up to the latter period, he had no definite notion of the real power of ether in surgery, having seen no case of its application in that science. He first made partial experiments, and recommended, but did not make decisive ones. The last took the risk and labor necessary to demonstrate or disprove its efficacy and, above all, the safety of the process, which until this time had been believed to be dangerous to life.

Eventually the report by the trustees of the hospital and a special committee of Congress awarded the major honor to Morton. Morton, however, through this controversy appears to have been actually impoverished and never to have received a just recompense for his great achievement in surgery.

The first announcement of the discovery was published by Henry J. Bigelow in the *Boston Medical and Surgical Journal* of November 18, 1846. The latter, although the youngest member of the surgical staff, became Morton's principal defender and the leading writer on *anæsthesia*. The coming of this word "*anæsthesia*," for the early cumbersome phrase—"insensibility during surgical operations"—is attributed to Oliver Wendell Holmes, then occupying the chairs (the settee, as he preferred to call it) of physiology, chemistry, and anatomy at the medical school.

In a final review of the development of *anæsthesia* from our present perspective, it is but belated justice to add the name of Dr. Crawford W. Long of Athens, Georgia. Antedating even Jackson's claims to the discovery, Long had observed that during a series of hilarious "ether frolics" in his office, some of his friends became so intoxicated by the drug that their cuts and bruises were quite painless. Making the most out of this observation, he had fully etherized and operated upon at least 6 patients in his country practice prior to 1846. Only Long's self-effacing character and his lack of a large hospital in which to demonstrate his method prevented him from becoming the undisputed discoverer. Unfortunately for him, his work remained unknown outside of Georgia until 1854, whereas in Morton's case, through the enthusiastic backing of Dr. Warren and the other members of the surgical staff, the discovery was broadcast over the civilized world within a very few months.

Henry J. Bigelow, who has just been mentioned in connection with the ether discovery, became the guiding hand of the hospital during the next 40 years. The son of Jacob Bigelow, then head of the medical staff, he graduated from Harvard Medical School in 1841 and completed his medical studies abroad under such famous

masters as Pierre Louis and Sir James Paget. Eccentric, masterful and of great personal charm, he excelled from the beginning in whatever field he developed. Outside of medicine these interests were diversified to the extent of driving a superb pair of horses, shooting, raising monkeys and fancy pigeons, playing on the drum and French horn, sleight of hand, and renovating old paintings.

In his profession Bigelow was a technician, pathologist, and teacher with few equals, driving home his surgical lectures with beautiful free hand drawings on the black board and dissections on the cadaver. At a time when reduction of hip dislocations was attempted with the aid of block and tackle, he worked out the key to its solution by scientific manipulation through flexion of the powerful iliofemoral or "Y" ligament which now bears his name. Perhaps of even greater importance was his perfection of a lithotrite which revolutionized the current methods of treating stones in the bladder. Previous attempts at litholapaxy by Civiale in France and by Clover and Thompson in England had been unsatisfactory because their instruments were too small to pulverize bladder calculi and evacuation of the remaining debris was far from complete. Surgeons did not dare prolong these manipulations with the lithotrite for over two minutes and the angular fragments of stone left behind in the bladder were frequently the cause of fatal complications. It remained for Bigelow to show that the male urethra could admit a suitably shaped instrument as large as size 30 (French) and, with his unusual skill in designing instruments, to improve the crushing jaws and the evacuator so that all particles of the stone could be removed. Under these circumstances Bigelow was able to perform the entire operation under *anæsthesia* at one sitting, sometimes taking as long as 2 hours to carry it out. Bigelow also invented the first revolving nose-piece for microscopes and made minor improvements in almost every instrument in the surgical amphitheatre.

Dr. Bigelow was one of the most picturesque characters who have been associated with the hospital and without question the most autocratic. While he became the leader in the introduction of ether *anæsthesia* at a time when he was the junior member of the surgical staff, he was later frequently in opposition to innovations. Thus when Dr. James C. White, the writer's grandfather, was founding one of the first skin clinics in the country and had been promised a number of hospital beds, Bigelow forced the trustees to reverse their decision. The same con-

servatism came into action against the proposal to found a hospital training school for nurses which was agitated in 1873.

It will be remembered in connection with the training school that the original brochure of Drs. John C. Warren and James Jackson had stressed the importance of "kind, skilful, and discreet nurses." The early nurses were untrained, underpaid, and overworked. In spite of these handicaps some developed a high degree of efficiency and sense of devotion, but others, needless to state, were neither skilful nor "discreet." At the time of the Civil War there were 27 nurses who were paid seven dollars and fifty cents a month for working from five in the morning to nine thirty at night. In 1873 a committee of Boston women led by Mrs. Parkman, wife of one of the visiting surgeons and a friend of Florence Nightingale, asked the Trustees if a training school for nurses might be founded at the hospital. There were many objections on the part of both Trustees and hospital staff—most of all from Dr. Henry Jacob Bigelow who asked one of the trustees to state these objections, as politely as possible, to Mrs. Parkman. This lady a very keen and witty woman, after listening patiently answered with a gleam in her eye "Verily verily this is the hand of Esau, but I think I hear the voice of Henry Jacob."

Thanks to the persistency and tact of Mrs. Parkman's committee, a Training School for Nurses was organized in 1873 and permitted to staff some of the less desirable wards where the work was most difficult. Besides the actual nursing of patients, the work included washing post-operative clothes and bandages, as well as mending patients' clothes, scrubbing floors, and cooking. During its first 2 years, the school got off to rather a poor start, due to the lack of a competent head and the absence of co-operation on the part of the staff. The latter refused to aid in instructing the nurses and stated bluntly "Put the school out we do not want it our former way was better." Finally with the appointment of Miss Linda Richards, the school began to show its capabilities, forcing the Trustees three years later to admit that "these women, with right notions of their duties, will eventually prove a blessing to the sick of all classes of the community." In 1893 they referred to it as "that admirable and successful institution."

At the time that the hospital staff were beginning to realize the value of the trained nurse, Lister's applications to surgery of Pasteur's work were attracting attention in this country. But surgeons who were accustomed to operating in

the full regalia of stock, starched cuffs, and frock coat did not take kindly to operating gowns and a continuous saturation in a spray of carbolic acid. Bigelow records that he read Lister's first article in 1865 and had his house surgeon, Dr. Beach dress a couple of amputations by this new technique. "They did well. But other dressings did well also so that the new method was abandoned."

The complete adoption of the antiseptic, and a few years later of the aseptic technique, was brought about by Dr. John Homans' pioneer work in abdominal surgery. Ovariectomy had been attempted in the hospital six times between 1830 and 1858 with a mortality of one hundred per cent. As a result the trustees had ruled that this operation should no longer be attempted in the hospital. Not deterred by this ruling, Dr. Homans took these cases outside and performed his first successful removal of an ovarian tumor in 1877 under Lister's carbolic acid spray. That he should have lost four previous cases from sepsis without the spray and then had five consecutive successes with its use, made a profound impression. A story is still told of "Uncle John" starting his laparotomies with the words "Now gentlemen, let us spray." Abdominal surgery which had been regarded as a specialty and vigorously opposed by H. J. Bigelow and the older members of the surgical staff, became established under his influence and a new generation of surgeons developed under his leadership. These included J. Collins Warren, Maurice H. Richardson, Samuel Mixer, and C. B. Porter all of them men of unusually striking personality. Thanks to their efforts the period of hospitalization of the average surgical admission was reduced from 81 to 20 days.

The contemporary members of the medical staff were possessed of equally marked individualities. Of these, Reginald H. Fitz stands out because of his original work on appendicitis (1886) and pancreatitis (1890). James J. Putnam, appointed "Electrician" in 1872, because he built up one of the first neurological clinics in the country and Frederick C. Shattuck for his introduction of the high caloric diet in typhoid fever and his charming sense of humor which was so Rabelaisian in quality that nurses were required to remain at a respectful distance during his ward visits. The opening of a pathological laboratory under James H. Wright in 1896 led to his discovery of the blood stain which bears his name and to his description of the blood platelets from megacaryocytes in the bone marrow. The modern system of social service in hospitals originated here in 1903 inspired by Richard C. Cabot.

As one of the few large American hospitals to prepare for military action long before the United States declared war on Germany, the Massachusetts General Hospital Unit was ready to take the field in April, 1917. Under the command of Major F. A. Washburn, superintendent of the Hospital, Base Hospital No. 6 sailed in July and took over the French Military Hospital at Talence, outside of Bordeaux. This institution was enlarged to a capacity of 5000 beds and had cared for 24,122 sick and wounded by the time the Armistice was signed.

The most recent original development consists in a new type of hospital service for people of moderate means. The new Baker Memorial Hospital is undertaking to furnish rooms and nursing care at cost to this group of patients. On its part, the hospital staff has agreed to accept one hundred and fifty dollars as a maximum fee. To compensate for this, all possible routine work

is taken off the surgeons' hands by a staff of house officers, anesthetists, and record clerks, and, last but not least the bill is collected by the hospital. During 1931 the average patient's bill amounted to one hundred sixty-six dollars, of which sixty dollars was paid to his physician. This constitutes a notable experiment in hospital administration.

In looking back over the development of surgery in the Massachusetts General Hospital, it is quite evident that there have been two definite periods of expansion: the first followed the discovery of ether in 1846, the second the establishment of the aseptic operating technique in 1888. With the recent rapid physical enlargement of the plant, the establishment of special clinics for intensive study of tumors, goiter, peripheral vascular disease, etc., and the full time system of teaching, all signs point to a third period of increasing activity.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

DORRANCE'S book<sup>1</sup> is truly "the operative story of cleft palate" with chapters on etiology, embryology, pathology, anatomy, and speech training put in for completeness' sake. There are innumerable illustrations of instruments, procedures, and sutures. These date from the beginning of records and apparently include everything down to date so that in some parts the reproduction of old cuts and old complicated instruments make one feel that he is turning the pages of a very old publication.

The author states the operative story of cleft palate is by no means an easy task to narrate, and no one surgeon can have complete claim to any operative procedure since each method resulted from the experiences of many contributors whose efforts are interdependent." However Dorrance has admirably narrated the story and condensed a massive literature into a single volume that reads easily and makes available these old cuts that would never be seen elsewhere unless one took the pains the author has. With the text for study and over 4000 references to the literature included, one would have some difficulty in establishing any procedure as new and revolutionary in idea.

The story is presented completely first, with good and bad procedures described without much criticism and then the author's conclusions are given in a concise, definite manner that show a complete grasp of the subject, and, more than that, a thorough study of the material that has been compiled. In the chapter on "Conclusions" is included a complete description of the author's push-back operation, and his operation for complete clefts. After reviewing literally hundreds of instruments described in the earlier procedures, one welcomes the lack of illustration of instruments in this part. The anatomical drawings, the illustration of one needle and the author's reasoning are adequate, and, almost for the first time, one begins to see a workable, definite surgical operation.

Dorrance believes that the lip should be closed in the first few months over the open alveolar cleft and the cleft allowed to close by the resultant lip pressure gentle molding with the hands, or adhesive, or an occasional section of the septum in the case of a badly protruded premaxilla in a double cleft is permitted. He then delays palate closure until the fifth year. This is done with medial and backward

displacement of the mucoperiosteum of the hard palate and the entire soft palate. This is accomplished in a two-stage operation with a length of palate arrived at that will permit complete closure of the nasopharynx.

For congenital insufficiency and partial clefts, the author's push-back operation is thought to be the answer to the problem. The entire mucoperiosteum is elevated and the arteries cut; this is returned to its bed as a delayed flap for 3 months. This flap is again elevated, the velum is loosened, the hamulus sectioned, and the entire palate pushed backward and anchored on the bony palate, and midline closure is done.

Everyone interested in cleft palate surgery must some time or other consult this book, or better still, have it available for reference, for no one could possibly remember all the points of "the story" as these occupy over 400 pages of the book.

The experienced operator might feel some doubt about a few statements, and a little more information or argument on these points by the author might save the beginner some worry. For example, Two fairly large postoperative holes are illustrated and the statement made that they would probably close with cauterization; the septum of an excessively protruded columella is shown as sectioned and ship-lapped backward but these septums are usually much thicker than illustrated and overlapping or crumpling them back usually so occludes one nostril as to cause difficulty later in closing the palate. The recent work of Logan on the position of the tooth buds is omitted—however to Dorrance, who advocates waiting until the fifth year, the extraoral position of the buds earlier in life will make no difference; no mention is made of the lip pressure failing to cause apposition of the spread alveoli as occasionally happens; section of the posterior palatine arteries is advocated without debating the point of preserving them as is done by many other operators; further discussion of the section of the hamulus might be of benefit, because without the complete section of the aponeurosis from the posterior border of the hard palate, section of this book or of the tendon itself does not allow much displacement of the palate; the illustrations are necessarily small because of their number, and the sharp outlining of some of them to bring in detail detracts in a few instances from the showing; two illustrations of operation show the completed palate and the note is made that the velum can meet the pharyngeal wall—this impression is even hard to be sure of on look

<sup>1</sup>THE OPERATIVE STORY OF CLEFT PALATE. By GEORGE MORTON DORRANCE, M.D., F.A.C.S. Assisted by EUGENE MURPHY, D.D.S. Philadelphia and London: W. B. Saunders Company, 1933.

ing at the actual patient, and there is no explanation of the good speech that is occasionally found in a person whose nasopharynx obviously does not close

JAMES BARRETT BROWN

IN his preface, Dr Kirschner states that the first volume of his work on *Operative Surgery* the American edition of which was published in 1931 may be considered as a unit in itself. This is true also of the second volume<sup>1</sup> which has just come to hand. Few surgeons possess the ability to describe their work and their observations in such simple and illuminating terms. His description of his operative technique and of the anatomical relations of the various organs is set forth in a most comprehensive and interesting manner. Each chapter is complete in itself and possesses the interest of a lecture on that subject. No superfluous words are used, yet nothing is omitted that has a bearing on the condition involved.

Dr Ravdin's translation is a masterpiece. The unwieldiness of a literal translation from the German has been entirely avoided and his personal comments scattered throughout the book add to the interest of the text. There are almost four hundred beautifully drawn illustrations mostly colored which supplement the clarity of the work. There is an excellent index.

Both author and translator should be congratulated on this volume which shows the result of many hours of painstaking and meticulous care in preparation and translation. Undoubtedly it will be a valuable addition to the library of many surgeons and will afford interesting as well as instructive reading.

WILLIAM A. HENDRICKS.

THE book *Surgery of the Thorax*<sup>2</sup> constitutes one of a series of modern surgical monographs published in England by G. Gordon Taylor. As its title would indicate it covers surgery of the chest, both of the bony structure and of the organs lying within. The first few chapters are devoted to such fundamentals as anatomy, physiology, general principles of treatment, and anaesthesia. The chapter on "Diagnosis" dwells chiefly with the use of X-ray

The book is well illustrated by diagrams and drawings, and in many instances the author has made use of some of the beautifully colored illustrations which appeared in Sauerbruch's *Chirurgie der Brustorgane*. A bibliography is appended.

The author has a remarkable aptitude in couching his thoughts in the fewest number of words. He is an excellent writer and the readers will be delighted with his method of exposition. As far as the subject matter is concerned, it is well covered and current opinions on various controversial matters are recorded—the author drawing from his own experience in some cases.

The book should be of interest to the internist who has to deal with thoracic cases and to the surgeon who is occasionally called upon to perform these operations. The book naturally cannot be compared to Sauerbruch's *Chirurgie der Brustorgane* or the two volume Lillienthal's *Thoracic Surgery* nor is it fair to do so as the book makes no pretense of covering the subject in such a thorough manner. For just this reason the book should be very popular because its appeal will be to that large group of physicians who are interested in the tremendous progress being made in thoracic surgery but who have neither the time nor inclination to go into it as a specialty.

RALPH B. BETTMAN

THE textbook<sup>3</sup> on neurology by Brain is admirably fitted to the needs of student and practitioner.

Fundamental facts of anatomy and physiology which are essential to the understanding of disordered functions are treated in the first 121 pages in an unusually clear manner. Further details of the same sort are added where needed as in the sections on cranial nerves, peripheral nerves and spinal cord. The clinical sections are planned in what the author feels is the most practical, if not always the most logical arrangement. The order and arrangement are such as to reduce to a minimum confusion in the mind of the struggling beginner. Great care in preparation is evident throughout the books and there are remarkably few errors or misprints. A few rights and lefts need revision in the section on methods of stimulating the labyrinth. The frequent cross references and the heavy type headings under each disease greatly add to the book's usefulness. The author stresses the "predominant importance of psychological factors in causation of the neuroses and gives only such discussion of psychological theory as is necessary to explain the genesis of neurotic symptoms and the basis of a psychotherapy which is within the scope of the physician who is not a psychological specialist." More illustrations especially in the clinical sections would be welcomed. A very full up to date bibliography by subjects is given at the end of the volume. The usual high standard of the publishers has been maintained in material and appearance. This text should gain much use and popularity in America.

JOHN FAVELL.

THE writings of Professor Harington on the thyroid gland are of first importance to all students of this and the more comprehensive field of endocrine physiology. The present publication<sup>4</sup> is a scholarly review of thyroid disease and physiology with a detailed exposition of the chemistry of thyroid substances. The author has established the formula for thyroxine, synthesized it, demonstrated

<sup>1</sup>OPERATIVE SURGERY: THE ABDOMEN AND RECTUM. By Dr Martin Kirschner. Authorized translation by I. B. Ravdin, B.S., M.D. Philadelphia and London: J. B. Lippincott Company, 1931.

<sup>2</sup>MODERN SURGICAL MONOGRAPHS. Edited by G. Gordon Taylor, O.B.E., M.A., F.R.C.S. SURGERY OF THE THORAX. By T. Holmes Hetherington, M.C., M.A. (Oxon.), F.R.C.S. (Eng.). With a preface by R. A. Young, C.B.L., M.D. F.R.C.P. London: Constable and Company Ltd., 1932.

<sup>3</sup>DISEASES OF THE NERVOUS SYSTEM. By W. Russell Brain, M.A., D.M. (Oxon.) F.R.C.P. (Lond.). London: Oxford University Press, 1931.

<sup>4</sup>THE THYROID GLAND: ITS CHEMISTRY AND PATHOLOGY. By Charles Robert Harington, M.A., Ph.D. F.R.S. London: Oxford University Press, 1932.

the physiological activity of the manufactured product, and proved the presence of the associated substance, diiodotyrosine in the parent protein. The chemical procedures used in this work are set forth explicitly in several chapters. One imagines that the ability to make such progress rests in part on exhaustive historical scholarship and the intimate acquaintance with the successes and failures of former times, together with the ability to analyze the processes of success or failure. In addition to its importance for the physiological chemist, the clinician and physiologist will find much informative material in the discussions of thyroid disease and physiology in this book.

The first three chapters on history, early chemistry and golter are preëminent for their presentation of the historical progress of knowledge in these fields. Many readers may not appreciate the Latin quotations but all will be entertained and instructed by the account of the use of calcined sponge for bronchocoele in England in the 18th century. In this story Doctor Bate, who had a daughter suffering from golter, disclosed the prescription to the apothecary whose apprentice transferred it to Mr. Broc-hurst who discovered it to Doctor Jones whose original recipe and prescription are given in complete detail.

Such detailed study of historical material is of real value for the reasons stated above. The biochemical aspects of Graves' disease are finally considered and the direction of further studies on the subject suggested. This monograph enriches the scientific literature of medicine, physiology and chemistry.

PAUL STARR.

THE first edition of Gellhorn's *Gynecology for Nurses* appeared in 1930. The demand for a second edition within 3 years bespeaks the appeal, popularity and usefulness of this textbook which was written to meet the requirements of student nurses. Undoubtedly it has helped to cement the professional relations of nurse and doctor thereby insuring intelligent nursing service for gynecological patients.

A thorough revision, an increase in the number of illustrations and the addition of chapters on "Constitution" and "The Endocrine System" are the outstanding changes in this new edition. The number of questions after each chapter has been increased; they will prove helpful to the student in identifying and remembering the salient features of each topic as she reads it.

The reviewer wishes to congratulate the author on his masterful, but concise, presentation of the subject and is pleased to recommend Gellhorn's *Gynecology for Nurses* both to teachers and students. Many training schools would make a wise choice by adopting it as their preferred text in gynecology.

GEORGE H. GARDNER.

*Gynecology for Nurses*. By George Gellhorn, M.D., F.A.C.S. 2d rev. and enl. ed. Philadelphia and London: W. B. Saunders Co. 1931.

IN the introduction of his book<sup>1</sup> Van der Spek presents an historical survey of the development of our knowledge concerning sarcoma of bone. Etiological factors are discussed with special emphasis upon the evidence for and against the etiological relationship of trauma to the origin of osteogenic sarcoma. The classification of the bone registry is discussed. The chapters on symptomatology, diagnosis, prognosis, and treatment form a critical review of the literature upon the subject. A review of the literature indicates clearly that conservative surgical procedures, i.e., local resections, have not proved to be of value. The primary mortality is also higher with conservative than with radical operative methods. Most authorities are agreed that conservative surgical treatment should be rejected. Certain authors, however, still believe that there is a definite field for local resection in selected cases. The results obtained by Professor Noordenbos seem to favor disarticulation as against amputation. In 7 cases of sarcoma of the tibia, 3 were treated by disarticulation and are living whereas only 1 of 4 treated by amputation is alive. It is of interest to note that of 7 patients suffering from osteogenic sarcoma of long bones who are living and free of disease, 4 were treated by disarticulation. The author draws the following conclusions regarding the surgical treatment of osteogenic sarcoma: (1) curetting and resection are to be rejected (2) amputation is justifiable though not desirable, especially if it can be done through the bone, proximal to the joint between it and the involved bone (3) disarticulation at the hip for osteogenic sarcoma of the lower limb and forequarter amputation for similar tumors of the upper limb must be considered as the best surgical treatment in osteogenic sarcomata of the long bones.

The author reports 43 cases of osteogenic sarcoma and 9 cases of giant cell tumor of bone.

Concerning the treatment of giant cell tumors the author advises resection and, if necessary, amputation in preference to curettage.

The author mentions but dismisses lightly the important results of radiation of giant cell tumors that have been accomplished in various American and European radiological centers, notably the Memorial Hospital, New York, and the Curie Institute in Paris.

MAX CUTLER.

THE authors express the hope that their volume<sup>2</sup> may fill a gap in medical literature between orthopedics and neurology. Clarity on each subject is essential in the treatment of paralysis in children and this book makes a real contribution to such a synthesis. It is presented in three sections. The first considers the physiology of movements, location of lesions causing paralysis, the etiology of these lesions and the diagnostic significance of physical signs. The second section describes the 19 condi-

<sup>1</sup>OSTEOGENIC SARCOMA. By J. Van der Spek.  
<sup>2</sup>PARALYSIS IN CHILDREN. By H. G. Gordon, M.D. D.Sc. F.R.C.P. (Ed.) and H. Parnass Brown, M.D., M.S. (Lond.). London: Oxford University Press, 1931.

tions or groups of disorder most frequently encountered. In the last part general lines of treatment and some detailed account of physiotherapy are given. Chapters on rest, massage, electricity, re-education, hydrotherapy, splints, treatment of contractures, and a non-technical discussion of operative procedures make up this section. Case histories are used freely. There are many excellent diagrams and photographs. The pediatrician, orthopedist, and neurologist will especially appreciate this clean cut presentation of an overlapping field of work.

JOHN FAVILL.

THE first part of the second half of the fourth volume of Stoeckel's *Handbuch der Gynäkologie*<sup>1</sup> devotes seven hundred pages to the roentgen treatment of benign gynecological diseases. This volume is in keeping with other volumes of this monumental work which have been previously reviewed. It is encyclopedic in character and includes a bibliography of 75 pages.

Wintz and Wittenbach, the authors of this volume, have included all of the world literature on this and allied subjects. They have made the work cumbersome by virtue of the fact that it is so all inclusive.

The section on the methods of technique of roentgen therapy includes the method of almost every well known clinic the world over. It would be much more practical and usable if the rather tiring and monotonous descriptions of the many discarded and outdated methods were not included. This same criticism holds for the sections on clinical indications, the treatment of inflammatory gynecological conditions and that on superficial therapy. The attempt to make each section historically complete makes the volume too ponderous for practical use—in fact too ponderous even for the purpose of this entire set of books viz. encyclopedic.

RALPH A. REIZ.

THE publication of a monograph to denote the progress and the outstanding features developed in the science of radiology from the date of Roentgen's discovery to the present, became one of the projects of the First American Congress of Radiology held recently in Chicago.<sup>2</sup> The authors of the volume are some 26 leaders in American radiology.

The first two chapters are devoted to the discovery of roentgen rays and radium, with interesting incidents in the lives of these pioneers. Due credit is given Hertz and Lenard and many others as well as Becquerel, for their early work which led up to the discovery of X ray and radium. Following Roentgen's announcement of a new kind of ray<sup>3</sup> physicists and engineers immediately became interested and soon its application to medicine was realized.

<sup>1</sup>THE HANDBUCH DER GYNAKOLOGIE. Edited by W. Stoeckel. 4th ed. Vol. IV, pt. II. KLEINER HANDBUCH DER GYNAKOLOGIE. ROENTGENRADIATION. 1st part.—DIE BEHANDLUNG DER GYNAKOLOGISCHEN ERKRANKUNGEN. By H. Wintz and F. Wittenbach. Munich: J. F. Bergmann, 1931.

<sup>2</sup>THE SCIENCE OF RADIOLOGY. Edited by Otto Glasser. Springfield, Illinois: Charles C. Thomas, 1931.

In America credit for obtaining the first radiogram probably belongs to Professor M. I. Pupin of Columbia University although Edison began work on the day of the announcement of Roentgen's work, followed shortly by numerous widespread reports of the successful production of radiograms. The application of the new discovery to medical and surgical diagnosis, as well as therapy, opened up an entirely new field. Employed at first for the demonstration of bones and certain foreign bodies, the X ray was soon found useful in many other phases of diagnosis.

The physics of X ray is well presented (including the subjects of X ray spectra, intensity absorption, scattering, ionization and fluoroscopy). The development of roentgen ray apparatus beginning with that used by Roentgen provides an interesting chapter, as does the development of tubes, the first being a gas tube as used by Crookes. In the development of recording media and screens, the work of George Eastman, Thomas Edison and Dr. Herbert Thielkeld Edwards and of Carl Patterson is outstanding.

The importance of roentgen ray dosage was realized by the pioneers and numerous methods of determination were used which culminated in the adoption of the international unit to be designated by *r* by the Second International Congress of Radiology at Stockholm in 1928.

A difficult rôle, indeed is that of tracing the progress of radiological diagnosis from the first reported radiogram in the United States to the present time. Due credit is given the pioneers and their followers, both in the United States and elsewhere, in the various fields of their endeavor.

The various wars and later the World War produced a new phase of radiology—that of military roentgenology. The portable apparatus, refined technique in foreign body localization are products of this branch.

The importance of the roentgen ray in therapy was realized early by the pioneers, in fact as soon as skin reactions were observed. As early as January 29, 1896 E. H. Grubbe of Chicago applied the new ray in a case of carcinoma of the breast. The road of the roentgen therapist has not been a smooth road. He has met many failures but his successes have spurred him onward until today roentgen therapy is a most valuable adjunct in the field of therapy.

The progress in the field of radiology was accompanied by a similar progress in the use of radium, which began with its discovery in 1898 by the Curies. Physicists and chemists anxiously entered the new field of research. It was soon discovered that three types of rays emitted from this new radioactive substance. A theory of the successive radioactive transformations was formulated by Rutherford and Soddy in 1903 thus systematizing the whole subject. A unit to be used in radiotherapy was adopted in 1910 at the Radiology Congress in Brussels and was termed the *curie* in honor of M.



and Mme. Curie. An international radium standard of 21.99 milligrams of pure radium chloride was accepted by a specially appointed committee which met in Paris, March, 1912.

The employment of radium in medicine followed the burn of Becquerel in 1901. Its first application was in the field of dermatology but was soon used in cases of cancer. Wickham in 1907 treated successfully an angioma on a child's forehead. Abbe of New York was probably the first to insert radium needles into tumors. Radium was soon found to be a valuable therapeutic agent until at present there are few fields of medicine and surgery in which radium is not used to advantage.

The effects of roentgen rays upon heredity material is discussed in an interesting chapter much experimental work having been done using insects and plants.

A short chapter is devoted to the biological effects of roentgen rays and radium. Absorption of radiation by living tissues produces a series of changes in cells leading to temporary injury or their death, depending upon the intensity of radiation and their sensitivity to radiation. The magnitude of the biological effect is equal to the dose regardless of wave length.

The question of roentgen ray protection becomes more and more important with the development of high voltage therapy equipment.

The fundamental requisite for any one dealing with medical radiology is that the individual be a physician trained in medical science. Instruction of undergraduates in medical radiology is important, even though the undergraduate does not anticipate pursuing this branch as a specialty. This instruction should not be terminated with his graduation, but should be followed in the hospital with instruction to internes. The teaching of radiology to graduate

physicians becomes a problem. Medical Schools and Class A hospitals offer such instruction. Steps are now being taken by the various radiological organizations in the United States to arrange for the qualifications of candidates for the specialty of radiology.

Radiology has proved its usefulness not alone in medical science but also in the field of industry and chemistry. Within these fields may be included chemical analysis by roentgen rays, practical application of absorption measurements, industrial radiography of metal castings, welds, various automotive parts, the analysis of the fine structures of materials by roentgen ray and diffraction analysis of various metals, liquids, certain textile materials and of normal and pathological tissues.

As early as March, 1897, a skiagraphic society was organized in England. The organization of this society was followed by similar organizations in other countries. In the United States the Roentgen Society was organized March 26, 1900 in St. Louis, Missouri, the name later changed to the American Roentgen Ray Society. The American Radium Society was organized in 1916, the American College of Radiology in 1923, the Western Roentgen Society in 1925 to be changed in 1930 to the Radiological Society of North America, the First American Congress of Radiology in 1933.

Chapter 23 is devoted to a discussion of the foundations of radiation therapy including ultraviolet visible and infra red radiations from the sun and artificial sources. The two final chapters are devoted to a discussion of the nature of cosmic rays and of the Gurnitich rays.

The book should be of interest and value not only to the specialist in radiology but to all those interested in the history and progress of medicine.

E. E. BURKE.

## BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

TRANSACTIONS OF THE AMERICAN GYNECOLOGICAL SOCIETY. Vol. LVIII. For the Year 1933. Edited by Otto H. Schwall, M.D. St. Louis: C. V. Mosby Co., 1934.

LA CHYLÉSTÉRIE DES RARES DRAMAIS. By P. L. Mir. Paris: Masson et Cie, 1934.

COLLECTION TRISTE. NOUVELLE BIBLIOTHEQUE DE L'ETUDIANT EN MEDICINE. Published under the direction of Prof. E. Forgue. ANATOMIE CHIRURGICALE. Paris: G. Doin & Cie, 1934.

DE LA DOULEUR. By Dr. J. Westfield. Paris: G. Doin & Cie, 1934.

LES TUMEURS DE LA LOGE CERVICELLEUSE FORME CHIRURGICALE. PORTUGAISE. DIAGNOSTIC ET TRAITEMENT. By Th. de Martel et J. Guillaume. Paris: G. Doin & Cie, 1934.

LA PRATIQUE CHIRURGICALE ILLUSTRÉE. By Victor Panchet. Vol. XIX. Paris: G. Doin & Cie, 1934.

OXFORD MEDICAL PUBLICATIONS. A SHORT HISTORY OF SOME COMMON DISEASES. By divers authors. Edited by W. R. Bett, M.R.C.S. (Eng.) L.R.C.P. (Lond.) London: Oxford University Press, 1934.

ESTUDIO ETIOLOGICO Y TOPOGRAFICO DE LOS PROCESOS LOCALIZADOS DEL TORAX. By Raúl A. Piaggio Blanco and Federico García Casparro. Montevideo: Industrial Gráfica, 1933.

OPERATIVE GYNECOLOGY. By Dr. H. v. Pezham and Dr. J. Amreich. With an introduction to the edition in English by George Gellhorn, M.D. Authorized translation made by L. Kneer Ferguson, M.D. Vols. I and II. Philadelphia, Montreal, and London: J. B. Lippincott Company, 1934.

LEHRBUCH DER OPERATIVEN GEBURTSHILFE; FÜR ARZTE UND STUDIRENDE. By Prof. Dr. Georg Winter and Prof. Dr. Josef Hallman, in collaboration with Prof. Dr. W. Beathin and Prof. Dr. H. Naujoks. 2d ed. rev. ed. Berlin and Vienna: Urban & Schwarzenberg, 1934.

# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVIII

JUNE, 1934

NUMBER 6

## EXPERIMENTAL STUDIES IN GASTRIC PHYSIOLOGY IN MAN

### II A STUDY OF PYLORIC CONTROL. THE RÔLES OF ACID AND ALKALI<sup>1</sup>

HARRY SHAY M.D. AND J. GERSHON COHEN M.D. M.Sc. (Med.) Philadelphia

SINCE early antiquity the muscular intension comprising the pylorus has engaged the attention and imagination of medical investigators. The nomenclature, from the *πυλωρός* of Rufus<sup>2</sup> of Ephesus to the "butler" of Gregory Cole has indicated, vaguely, the nature of the pyloric action, but as with the Sphinx of Thebes, no Oedipus has appeared who has definitively solved the riddle of its control.

That this narrow muscular strip has made great appeal to the imagination of our early researchers is attested to by a consideration of this same nomenclature. The change from the simple "doorkeeper" (*πύλη*, gate, *οὐρός* guardian) of Rufus of Ephesus to the "just doorkeeper" (*janitor justus*) of Galen marks the first attempt, to be repeated later to endow the pylorus with more than perfunctory powers. The Middle Period, suspicious and ecclesiastical, disallowing the personification in "judicious" pylorus preferred *portanarius* (*portanarius*, *portunarius*, *portunarius*, *portunarius*) obvious corruption of *portarius*—the simple doorkeeper again. The Seventeenth Century, humanizing and intellectual brought with it the concept, developed so fully by Van Helmont, of the pylorus as *rector*, or

ruler again the gratuitous endowment of mind to matter. Writing in 1652, this author supposed the pylorus to exert an absolute power over the other gastric fibers, and to possess a power of judgment (*arbitrium*) which it exercised at will. The *rector* opened at the completion of gastric digestion not because of stimulation by the chyme, but because of its knowledge of the gastric processes. Vomiting he explained further, was a purely arbitrary action of the *rector* and derived from its ability to differentiate between substances beneficial and inimical to the economy. As late as the first quarter of the Nineteenth Century French investigators were still writing in the style of Van Helmont: "On objectera peut-être contre ce tact délicat que nous attribuons au pylore, sentiment exquis par lequel il exerce une espèce de choix sur les aliments qui le traversent."<sup>3</sup> Thus Richerand in 1825. And he says further: "Doué d'une sensibilité particulière et très délicate, le pylore peut être regardé comme une espèce de sentinelle vigilante qui empêche que rien ne passe dans le conduit intestinal qui n'ait éprouvé les changements convenables."<sup>4</sup>

<sup>1</sup>One will object perhaps to the sensitive judgment which we attribute to the pylorus, an exquisite discrimination through which it exercises a kind of selectivity over the foods which traverse it.

<sup>2</sup>Endowed with a keen and very delicate sensitivity the pylorus can be regarded as sort of vigilant sentry that hinders from entering the intestine and from undergoing the conventional changes any food not proved beneficial.

<sup>3</sup>Authorities variously place Rufus as having lived in the period of Ptolemy (272-27 B.C.) and of Galen (131-200 A.D.). *Galenus de Rufus* (Ephesus), Ch. Deromberg, Imprimerie Nationale, Paris 1879, preface p. 11.

<sup>4</sup>Awarded the Alvarreza Prize for 1931 by the College of Physicians of Philadelphia. Presented for publication with the permission of the College. From the Gastro-intestinal clinic of the Jewish Hospital and Rostenberg Department of Graduate School of Medicine University of Pennsylvania.

In view of the paucity of established scientific facts of gastric physiology it is not astonishing that such beliefs should have prevailed. After all the accidental gunshot which was to inscribe the name of the American Army surgeon Beaumont in the medical Hall of Fame and to actuate the beginning of modern gastric physiology was not fired until 1822. True the stomach tube had been used in 1812 by Phillip S. Physick.<sup>1</sup> This does not postulate an established use or even knowledge of the instrument however since historically the invention of the tube is usually credited to Adolph Kussmaul (27) born in the very year of the Alexis St. Martin incident. Even the important constituents of the gastric juice were still to be discovered: hydrochloric acid Prout 1824, pepsin Theodor Schwann 1836.

Although Beaumont authored the beginnings of modern gastric physiology formal experimental methods cannot be considered to have been introduced until the experimental fistulas of Bossov in 1842 and Blondlot in 1843. But it remained for Roentgen to give to medicine in 1895 the ideal method for studying gastric motility which method was first applied experimentally by Cannon in 1897.

The results of our own experiments, to be detailed presently, it seems to us, indicate not a new concept but rather a revision of one of the oldest since they establish the pylorus as a door—emphatically not autonomous.

Gastric motility may be considered to be the result of three components: gastric peristalsis, gastric tonus, and the state of the pylorus. It is our intention to consider briefly the first two of these components and to present experimental data which after analysis cause the third component, the *state of the pylorus* to emerge as the most important factor in gastric emptying.

#### EXPERIMENTAL METHOD

All studies were made on human subjects by means of roentgen examinations. The patients were completely studied in order to rule out as far as possible any organic gastrointestinal disease. Cases were selected to represent the entire range of gastric acid secre-

tory response from achlorhydria to hyperchlorhydria. All patients were repeatedly intubated in the clinic over a period of weeks so that psychic factors resulting from intubation were eliminated. Standard conditions for the complete study were insisted upon. No drugs were permitted. No studies were made if the patient had had any psychical disturbance during the preceding day. The evening being the best available time for the examinations, the following was the routine employed. The patient was permitted to eat his usual lunch at noon and at 3:00 p.m. two slices of dry toast and a cup of tea without cream were ingested. Nothing was taken thereafter until 8:00 p.m., when the studies were begun.

The mouth test meal consisted of 250 cubic centimeters of lukewarm tap water containing 2 ounces of barium sulphate. All test substances in this group of experiments were added to the water and barium meal, the total volume remaining constant. The gastric emptying time for each subject under the standard conditions was determined with the water and barium meal. This was checked by a second study and rechecked at the completion of all the tests. Under the conditions outlined, we found very little variation in gastric emptying in the same individual with similar test meals. In most instances, the results were practically identical and in the others the fluctuation did not exceed 10 per cent.

The emptying time for the water and barium meal established, new studies were made in which hydrochloric acid (0.09 to 0.53 per cent) or sodium bicarbonate (1 and 5 per cent) solutions were used. The effects on gastric motor function and on the action of the pylorus were studied serially by fluoroscopic and roentgenographic examinations. Observations and records were made during the first 5 minutes after the ingestion of the meal, the patient having been urged to drink rapidly. Records were made at 15, 30, 60 and 90, and at 120 minutes after ingestion or at such time when complete emptying had occurred or a constant residue with the water and barium meal had been obtained.

In another group of patients, the effect of the agents was studied by applying them directly to the duodenal mucosa. Standardiza-

tion of individual gastric emptying was determined as above. In addition, gastric motility was determined after duodenal intubation, in order to note any mechanical effect of the tube. We found *no change* in gastric motility to result from the mere presence of the tip of the tube in the duodenum and of the tube through the pylorus. Serial roentgenographic data were recorded as before.

The duodenum was first intubated with a Rehmann tube. The test agent was then slowly instilled into duodenum while simultaneously the water and barium meal was taken. The duodenal instillation was regulated with a Murphy bulb, the rate of instillation in this series varying from 20 to 100 drops per minute.

In addition to the solutions of acids and alkalis, the effects of many other substances were studied. Included were milk and its constituents, various strengths of neutral salts and irritants, such as pepper. This report however will be limited to the studies with the acid and alkaline solutions. A few of the milk experiments will be introduced but only in so far as they are necessary to explain some of the results of previous investigators. This report is based on 176 serial X ray examinations in the manner outlined. In order to obviate confusion, we will group our findings and then offer our explanation of the results obtained.

#### SUMMARY OF EXPERIMENTAL DATA

Group I Weak acid (0.09 to 0.23 per cent) taken by mouth (Table I)

A. Three patients who had shown a *normal acid secretion with the Ewald meal*. The weak acid meal produced a slight gastric motor delay in one, no change in motility in one, and a slight increase in motility in the third, as compared with the gastric emptying obtained with the standard water and barium meal.

B. Seven patients who showed a *hyperchlorhydric response to the Ewald meal*. Five showed practically no change, one registered a slight delay in motility and one a small increase.

C. Six subjects who showed an *achlorhydric response to the Ewald meal*. All showed a marked delay which varied from 50 to 150 per cent as compared with the motility of the standard water and barium meal.

Thus the change from the water and barium meal to that of approximately 0.2 per cent

TABLE I —EFFECT OF WEAK ACID (HCL) SOLUTIONS ON GASTRIC MOTILITY

Name	Time (hrs.)	Water G.R. %	Acid G.R. %	Strength of final Acid %	Acid response to Ewald meal
J. M.	1	25	30	0.10	Normal
H. H.	1	60	40	0.20	Normal
R. P.		E.	E.	0.12	Normal
A. C.	1	25	E.	0.13	Hyperacid
D. G.	1	50	7	0.18	Hyperacid
G. L.		30	30	0.09	Hyperacid
H. O.		30	25	0.5	Hyperacid
J. D.	1	E.	E.	0.13	Hyperacid
M. N.	1	20	20	0.18	Hyperacid
H. W.	1	15	15	0.16	Hyperacid
A. C.	1.5	E.	60	0.10	Anacid
O. H.	1	E.	25	0.10	Anacid
R. E.	1	E.	50	0.18	Anacid
L. M.	0.5	E.	85	20	Anacid
S. I.	0.25	E.	50	0.09	Anacid
C. S.	0.25	E.	60	0.1	Anacid

Time in hours—period of observation.

Water—gastric residue with water and barium meal.

Acid—gastric residue with acid meal.

E—empty.

G. R. %—gastric residue percentage.

See Table II, p. 938

hydrochloric acid evoked practically no change in gastric emptying except in patients with achlorhydria.

Group II Strong acid (0.24 to 0.53 per cent) taken by mouth (Table II)

In this group a marked gastric motor delay was obtained in all instances regardless of the Ewald secretory response. This delay was so marked, in most cases that no attempt to follow through to complete gastric emptying was made. The delay was gauged by the gastric residue at the time when the standard water and barium meal had previously been emptied. Relatively the achlorhydric again showed the greatest changes. The following example will indicate the delay that may be produced. An achlorhydric (A. C.) emptied the standard barium and water meal in 1.5 hours. The same stomach after a similar amount of 0.51 per cent hydrochloric acid still showed a gastric residue of 50 per cent at the end of 4 hours. In general, the hyperacid group registered the least relative increase in motor delay.

Group III Sodium bicarbonate (1 per cent) taken by mouth (Table III)

A. Three patients who had shown a *normal acid secretion with the Ewald meal*. All yielded a definite decrease in the time of gastric emptying.

TABLE II.—EFFECT OF STRONG ACID (HCL)  
SOLUTIONS ON GASTRIC MOTILITY

NAME	Time (hrs.)	Water G.R. %	Acid O.R. %	Strength of meal Acid °	Acid response to Ewald meal
J. M.		5	75	55	Normal
H. H.		60	80	55	Normal
R. P.		E	40	40	Normal
A. C.		5	45	45	Hypersacid
D. G.		50	75	5	Hypersacid
G. L.		30	30	47	Hypersacid
H. O.		30	30	40	Hypersacid
J. D.		E	30	40	Hypersacid
M. W.		30	40	40	Hypersacid
H. W.		5	40	40	Hypersacid
A. C.	1.5	E	100	0.51	Acid
O. H.		E	60	55	Acid
R. R.		E	25	5	Acid
L. M.	5	E	60	55	Acid
S. J.	5	E	30	40	Acid
C. S.	15	E	90	40	Acid

Time in hours—period of observation.

Water—gastric residues with water and barium meal.

Acid—gastric residues with acid meal.

E—empty.

O.R. %—gastric residues percentage.

B. Seven patients who showed a *hyperchlorhydric response to the Ewald meal*. The response was the same as in the normal group but showed relatively a greater decrease.

C. Six subjects who showed an *achlorhydric response to the Ewald meal*. All of these registered a gastric emptying time which was identical with that obtained with the standard water and barium meal.

Group IV Sodium bicarbonate (5 per cent) taken by mouth (Table IV)

A. Three patients who showed a *normal acid secretion with the Ewald meal*. In 2 no change in motility occurred as compared with the standard water and barium meal. In 1 a definite delay.

B. Seven patients who showed a *hyperchlorhydric response to the Ewald meal*. Six showed a decrease in gastric emptying time and in one no change was noted.

C. Six subjects who showed an *achlorhydric response to the Ewald meal*. In all of these a definite motor retardation was produced.

All members of A and B divisions showed definite delay with the 5 per cent solution as compared with the 1 per cent. In division C the degree of delay produced in most cases was comparable to that obtained in this group with the weak acid meal (Table I)

Lintvarev as early as 1901 from experiments on dogs with gastric and duodenal fistulas, concluded that the reaction of the stomach contents had no noticeable influence upon the passage into the duodenum of the initial or trial portion of the meal. More recently L. Gregory Cole (8) and others have insisted that gastric emptying begins immediately the ingested meal reaches the pylorus. This is true provided the pylorus is relaxed when the meal arrives. In every one of our observations upon achlorhydric patients, there was an immediate filling of the cap following the ingestion of any type fluid meal. We think that this is a normal reaction in achlorhydrics in a fasting state because, the intrinsic hydrochloric acid responsible for pyloric closure, being absent the pylorus is constantly patent. In most examinations in the normal and hyperacid cases immediate filling of the cap occurred while at times several gastric waves were observed before any trace of barium was detected in this area. This was caused we believe by the arrival of the meal at the pylorus while this muscle was still in contraction—a state produced by the presence in the duodenum of some incompletely neutralized acid which has reached it from the fasting stomach just before the meal was administered. Inasmuch as the initial portion on its arrival in the duodenum serves as a test of the acceptability of the gastric contents, the Lintvarev use of the term trial portion is very appropriate. If acceptable, this trial portion in the cap advances, and further gastric emptying follows. However should this portion be unacceptable stimulation of the duodenal mucosa occurs and a reflex is activated which results in pyloric closure. This closure is maintained until the trial portion is sufficiently neutralized or diluted to permit its passage to the adjacent distal duodenum. This accomplished pyloric relaxation takes place and further gastric emptying follows.

We do not subscribe to the opinion of Lintvarev that the speed with which the trial portion enters the duodenum depends upon the activity of gastric contraction. We are convinced that the immediate entrance of the trial portion into the duodenum depends upon the condition of the pylorus, and not upon

gastric activity This conclusion derives from the observations previously noted that immediate filling of the cap and practically continuous gastric emptying may be seen in achlorhydria after the ingestion of a bland meal, without a trace of gastric contraction.

Another phenomenon of interest was remarked when meals sufficiently irritating to set up the duodenopyloric reflex were administered. In every instance the cap alone showed filling with no progress beyond its apex for a variable time the duration of which was in direct proportion to the strength of the stimulant involved. It will presently be shown in the record of our duodenal tube studies, that by the application of various agents directly to the mucosa, we were able to control at will the gastric emptying.

From the facts stated, we advance that the control of the pylorus is dependent entirely upon stimuli acting on the duodenal mucosa. Normally the stimulant is the intrinsic hydrochloric acid, however, might must not be lost of the existence of numerous other agents<sup>1</sup> added by the food which through chemical or mechanical action can actuate this reflex. Further, that the area most sensitive to these stimuli is that portion of the duodenal mucosa just distal to the cap. From this it follows that the duodenum is the primary control in gastric emptying.

A number of questions suggest themselves from an examination of our experimental data (1) Why should the weak acid meal produce practically no effect on gastric emptying in the hyperacid patients an indifferent effect in those with normal acidity and a consistent delay in the achlorhydric group?

A water and barium meal ingested by an achlorhydric presents a trial portion to the duodenum incapable of setting up any reflex. The result is an uninterrupted progress of the meal through the pylorus and duodenum. A weak acid meal however, presents to the duodenum a trial portion which inaugurates

TABLE III.—EFFECT OF 1 PER CENT (NaHCO<sub>3</sub>) ON GASTRIC MOTILITY

Name	Time (hrs.)	Water G.R. %	Bicarbonate G.R. %	Acid response to Ewald meal
J. M.	1	5	E.	Normal
H. H.		60	E.	Normal
R. P.		E.	E. (1/4 hrs.)	Normal
A. C.	1	5	E. (1/4 hr.)	Hyperacid
D. G.		50	E. (1 hr.)	Hyperacid
G. L.		50	E. (1/4 hrs.)	Hyperacid
H. O.		50	E. (1/4 hrs.)	Hyperacid
J. D.		E.	E. (1 hr.)	Hyperacid
M. N.	1	50	E. (1/4 hrs.)	Hyperacid
H. W.	1	5	E. (1 hr.)	Hyperacid
A. C.	1 1/2	E.	E.	Anacid
G. H.		E.	E.	Anacid
R. R.		E.	E.	Anacid
L. M.	1	E.	E.	Anacid
S. L.	0 5	E.	E.	Anacid
C. S.	1	E.	E.	Anacid

Time in hours—period of observation.

W. = gastric residues with water and barium meal.

Acid—gastric residues with acid meal.

E.—empty.

G. R. % = gastric residues percentage.

the reflex and pyloric closure. And until sufficient neutralization of the trial portion to make it acceptable to the duodenum has been accomplished the closure maintains. Then the portion acceptable advances and pyloric relaxation ensues. Then further gastric emptying is repeated in the above sequence.

Is it not strange that the weak acid meal should cause such distinct and consistent gastric motor delay in achlorhydria yet be practically without effect when ingested by a hyperchlorhydric? Indeed the curiousness of this phenomenon is heightened when we recollect that in the latter we are adding acid to a fasting contents already acid while in the former no such additional acid is present. We (48) have shown elsewhere that the mechanism by which intragastric acidity is lowered is from all indications intrinsic in the stomach. Bayliss and Starling (50) have shown that the entrance into the duodenum of hydrochloric acid stimulates pancreatic secretion. Is it not possible that both the intragastric and duodenal neutralizing mechanisms in achlorhydria may be less efficient than those in nor-

<sup>1</sup>The mechanical action of extrinsic food factors is exemplified by the reflex which is produced by changes in osmotic pressure of the ingested meal; thus, hypertonic solutions of neutral salts, of glucose, and other sugars have all proved very effective in activating this reflex, while isotonic solutions of the same substances are without any effect. Even tap water when applied directly to the duodenal mucosa is sufficiently hypotonic to cause a retardation in gastric emptying when compared to the gastric motility which results from the duodenal stimulation of normal saline. P. is actively stimulate this reflex.

TABLE IV—EFFECT OF 5 PER CENT (NaHCO<sub>3</sub>) ON GASTRIC MOTILITY

Name	Time (hrs.)	Water G.R. %	Bicarbonate G.R. %	Acid response to Ewald meal
J M	5	25	20	Normal
H H		60	30	Normal
R P		E	60	Normal
A C		5	E ( 1/4 hrs )	Hyperacid
D G		20	5	Hyperacid
G L		30	E ( 1/4 hrs )	Hyperacid
H O		30	E ( 1/4 hrs )	Hyperacid
J D		E	E ( hrs )	Hyperacid
M W		20	E ( hrs )	Hyperacid
H W		5	E ( 1/4 hrs )	Hyperacid
A C	5	E	40	Asacid
O H		E	5	Asacid
R R		E	30	Asacid
L M	5	E	60	Asacid
S I	5	E	60	Asacid
C B	5	E	20	Asacid

Time in hours—period of observation

Water—gastric residues with water and barium meal

Acid—gastric residues with acid meal

E—empty

G.R. %—gastric residue percentage

mal or hyperchlorhydric persons—a condition akin to the atrophy of disuse? It seems logical that in achlorhydries the absence of the normal activating stimulus has caused these mechanisms to become less responsive while in hyperchlorhydries the presence of an excessive acid secretion has resulted in a more highly sensitive mechanism. Our data obtained with the strong acid meals further bear out this possibility (Table II). While these meals produced definite motor delay in all three groups, those with hyperchlorhydria registered the least increased delay.

2. Why should a 1 per cent sodium bicarbonate meal yield no change in gastric motility in achlorhydries, while a similar meal hastens gastric emptying in normal persons and in hyperchlorhydries? Isotonic solutions of salt are unable to initiate the duodenopyloric reflex, while hypertonic and hypotonic do so readily.

In the normal and hyperacid groups the administration of the weak alkaline meal led to a partial or complete removal at least temporarily of the hydrochloric acid with the result that the gastric emptying was hastened.

The second part of the question presents no difficulty if our previous observation concerning the neutralizing mechanisms has any merit. If the intragastric neutralizing mechanism in hyperchlorhydries is most highly developed then the addition of a relatively weak neutralizing agent should be expected to aid neutralization in such a stomach more than in one with less active inherent neutralizing resources.

How explain the effects of the 5 per cent bicarbonate meal? The 5 per cent bicarbonate meal being definitely hypertonic, its entrance into the duodenum of an achlorhydric should set up the duodenopyloric reflex. Which is precisely what happens. The trial portion upon reaching the cap instigates pyloric closure. This endures until such time as the tonicity of the trial portion has been sufficiently lowered by the diluting agents as to become acceptable to the distal area. The duodenal stimulus thus reduced permits pyloric relaxation and further gastric emptying.

In the normal and hyperacid groups, the action of the 5 per cent bicarbonate meal is similar—modified naturally by the stomach acid. Thus in some cases, sufficient of the meal may be rapidly neutralized in the stomach so that a solution of bicarbonate remains, which solution on reaching the duodenum, has an action not unlike that resulting from the response to plain water and barium meal. In others, neutralization may take place, leaving a solution more nearly isotonic and resulting in an increased gastric motility. That sufficient excess of bicarbonate was universally present is obvious since there was in all cases a definite gastric motor delay as compared with that resulting from 1 per cent bicarbonate meal.

One fact stands out clearly from these data. Without a consideration of the gastric secretory response of the experimental subjects, no logical or consistent interpretation of the results would be possible. We believe that much of the conflict in previous experimental data concerned with this problem is due to the absence of such considerations.

We have set forth the factors involved in the duodenopyloric reflex considered from the gastric approach. We present it now from the duodenal approach.

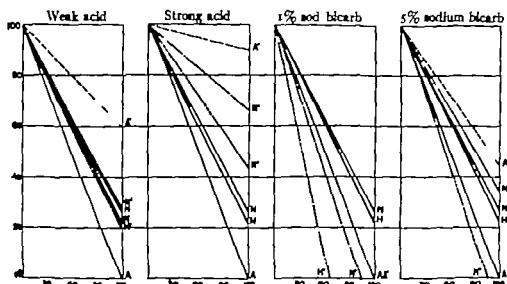


Fig. 1. Graphs illustrating Tables I to IV. Abscissae, time in minutes. Ordinates, Percentage of gastric residue. N, Normal acidity—plain water and barium meal residue; H, Hyperchlorhydria. A, Achlorhydria. N H A, Residue of the respective groups after special test meals noted.

#### THE EFFECT OF DUODENAL INSTILLATION UPON GASTRIC EMPTYING—TABLES V, VI, VII, VIII

Before proceeding, we wish to stress again the fact that the mere presence of the bucket in the duodenum and the tube through the pylorus had no effect upon gastric motility. Identical emptying was obtained with similar meals, whether or not the tube was present. Further, the effects of duodenal instillation of the various acids and alkalis on gastric motility cannot be properly interpreted without a knowledge of the test subject's gastric secretory response.

In achlorhydria the instillation of a 1 per cent bicarbonate solution had no effect on the gastric emptying of standard water and barium meal taken by mouth—a finding which emphasizes the acceptability of such a meal to the duodenal mucosa. In the normal and hyperacid subjects a similar instillation resulted in a more rapid gastric emptying of the mouth meal. The explanation for this is obvious in the light of our previous discussion. The duodenal neutralizing mechanism in the two latter groups, enhanced by a relatively isotonic solution, itself incapable of stimulating the duodenal mucosa, would, quite naturally, be able more readily to neutralize the spurts of acid gastric contents reaching it through the pylorus. This in turn would permit of a

quicker and more prolonged pyloric relaxation, thus favoring gastric emptying.

The duodenal instillation of a 5 per cent bicarbonate caused a considerable gastric delay in all cases. This solution being definitely hypertonic stimulates the duodenal mucosa initiating the duodenopyloric reflex and prolonging gastric evacuation. Here, too, though, the gastric acid played some rôle, as evidenced by the relatively greater gastric delay produced in the achlorhydria (Table V).

The acids similarly applied to the duodenum produced striking differences in gastric emptying in the three groups. Thus a 0.12 per cent hydrochloric acid solution introduced into the duodenum of an achlorhydric at the rate of 80 drops per minute caused a 90 per cent gastric motor delay of the standard water and barium meal taken by mouth. Under similar conditions in a patient with a high normal acidity only a 15 per cent delay was effected. In another instance a 0.09 per cent hydrochloric acid solution instilled at the rate of 100 drops per minute in an achlorhydric resulted in a 40 per cent gastric delay, but under similar conditions in a hyperchlorhydric caused no change in emptying of the standard water and barium meal taken by mouth. Such data lend further support to the suggestion already advanced that the duodenal neutralizing mechanism is more effective in



TABLE V.—EFFECT OF DUODENAL INSTILLATION OF WEAK ACID (HCL) SOLUTIONS ON GASTRIC MOTILITY

Name	Time (hrs.)	Intraduodenally		G.R. %	Acid response to Ewald meal
		Acid %	Drops per min.		
P. T.	5		80	5	Normal
H. S.	5	5	60	30	Normal
F. L.		99	00	E.	Hyperacid
F. G.		4	30	40	Hyperacid
H. R.		5	60	90	Acid
M. H.		5	75	00	Acid
I. J.	5	09	300	40	Acid
H. M.	5		80	90	Acid

Time in hours—period of observation.  
 Water—gastric residues with water and barium meal.  
 Acid—gastric residues with acid meal.  
 E.—empty.  
 G. R. %—gastric residues percentage.

TABLE VI.—EFFECT OF DUODENAL INSTILLATION OF STRONG ACID (HCL) SOLUTIONS ON GASTRIC MOTILITY

Name	Time (hrs.)	Intraduodenally		G.R. %	Acid response to Ewald meal
		Acid %	Drops per min.		
P. T.	5	49	40	100	Normal
H. S.	5	0.45	30	90	Normal
F. L.		40	5	95	Hyperacid
F. G.		46	40	90	Hyperacid
H. R.		45	90	90	Acid
M. H.		40	5	100	Acid
I. J.	5	5	180	100	Acid
H. M.	5	15	40	300	Acid

Time in hours—period of observation.  
 Water—gastric residues with water and barium meal.  
 Acid—gastric residues with acid meal.  
 E.—empty.  
 G. R. %—gastric residues percentage.

patients with gastric acid than in those without.

Hydrochloric acid in concentrations above 0.25 per cent introduced into the duodenum inaugurates and maintains the duodenopyloric reflex to such a degree as to cause very marked gastric delay in all the groups treated.

#### THE RÔLE OF GASTRIC PERISTALSIS IN GASTRIC EMPTYING

Peristalsis so spectacular and so easily observed, is the component of gastric emptying which appealed most strongly to the imagination of our early research scholars. Galen, the founder of experimental physiology questioned the Erasistrateans wanting to know why it was that the stomach contracted upon the food. Seventeen centuries later the process still bears investigation! So many and conflicting are the opinions of the nature of the part played by peristalsis in gastric emptying that its exact rôle is still to be defined.

More than 40 years ago Oppenheimer concluded that the peristaltic movements are not the primary factors in reducing the contents of the stomach. About the same time Roasbach, from studies on dogs reached a similar conclusion and expressed the opinion that the pylorus when firmly closed, could prevent the passage of even a trace of fluid into the duodenum, despite the strongest gastric contrac-

tions. In 1892 Hirsch (21) studying this problem in dogs with duodenal fistulas failed to see the exit of gastric contents through the pylorus with each peristaltic wave. He maintained that gastric emptying took place at successive intervals of from  $\frac{1}{4}$  of a minute to several minutes. Pavlov confirmed these observations and Walter Cannon's (4) roentgen studies in the cat added further support to this view.

On the other hand, Roux and Balthazard in 1897 just antedating Dr. Cannon's publications, concluded from observations on dogs that food entered the duodenum at the completion of each peristaltic wave. This opinion has been confirmed by the results of the animal experiments of Luckhardt, Phillips, and Carlson and of Wheelon and Thomas. The studies in human subjects of McClure Reynolds, and Schwartz, of Håneborg and of Cole (8) further support such a concept. Cole, particularly insists that the pylorus is open during the systole of every gastric cycle and that there is propelled through its lumen into the reservoir cap a small amount of liquid chyle.

Our experiments support the view that peristalsis is not of the first importance in gastric emptying. We do believe that the gastric peristaltic wave must be a potent force in advancing the gastric contents toward the pylo-

TABLE VII.—EFFECT OF DUODENAL INSTILLATION OF 1 PER CENT (NaHCO<sub>3</sub>) SOLUTION ON GASTRIC MOTILITY

Name	Time (hrs)	Intraduodenally Drops per min.	G.R. %	Acid response to Ewald meal
P. T.	1.5	100	E. (1 hr)	Normal
H. S.	1.5	80	E. (1 hr)	Normal
F. L.		60	E. (1.5 hrs)	Hyperacid
F. G.		100	E. (1 hr)	Hyperacid
H. R.	1	50	E.	Acid
M. H.	1	80	E.	Acid
L. J.	0.5	00	E.	Acid
H. M.	0.5	60	E.	Acid

Time in hours—period of observation.

W.—gastric residue with water and barium meal.

A.—gastric residue with acid meal.

E.—empty.

G.R. %—gastric residue percentage.

TABLE VIII.—EFFECT OF DUODENAL INSTILLATION OF 5 PER CENT (NaHCO<sub>3</sub>) SOLUTION ON GASTRIC MOTILITY

Name	Time (hrs)	Intraduodenally Drops per min.	G.R. %	Acid response to Ewald meal
P. T.	5	60	50	Normal
H. S.	1.5	100	60	Normal
F. L.	1	00	60	Hyperacid
F. G.		80	45	Hyperacid
H. R.		50	75	Acid
M. H.	1	50	90	Acid
L. J.	0.5	100	60	Acid
H. M.	5	100	100	Acid

Time in hours—period of observation.

W.—gastric residue with water and barium meal.

A.—gastric residue with acid meal.

E.—empty.

G.R. %—gastric residue percentage.

rus and, when the latter is open, a potent force in gastric emptying. Were peristalsis the motivating force of pyloric opening, however, we would expect to find (1) delayed emptying in the absence of peristalsis, (2) gastric emptying with each well defined wave, and (3) enhanced peristalsis in a normal stomach upon the induction of pylorospasm. Actually in many instances none of these phenomena obtains. In our own experiments we have frequently seen the barium meal literally pour through the pylorus in a steady stream without the presence in the stomach of the faintest peristaltic wave. This is often observed in achlorhydria. We have also seen frequently, fluoroscopically, very violent gastric waves spend futile efforts against a pylorus which was actively contracted. Finally, we have never seen enhanced gastric peristalsis in a normal stomach after induced pylorospasm. On the contrary the induction of pylorospasm is rapidly followed by a cessation of gastric peristalsis, and a return of active peristalsis is not usually seen until the agent producing the pylorospasm has been removed. Our observations suggest a reciprocal relationship between pyloric contraction and gastric peristalsis with pyloric tone as the determining factor. Our experiments indicate further, how this tone, in turn, is dependent upon conditions in the duodenum. Such a view is not without support from antecedent investigations. At the turn of the century von Montz stated it is possible

that the signal for an inhibition of gastric peristalsis originates exclusively in the intestine. More recently Brunemeier and Carlson have shown that stimuli in the duodenum capable of producing contraction of the pylorus, induce at the same time by local reflex mechanisms inhibition of the tone and contractions of the empty stomach.

Summarizing we believe that gastric peristalsis plays an incidental part only in gastric emptying. That it is a propelling force of the gastric contents toward the pylorus we do not deny but through the pylorus only when the latter is open. With the process of pyloric opening we do not believe peristalsis to be concerned.

#### THE ROLE OF GASTRIC TONUS IN GASTRIC EMPTYING

Gastric tonus we believe is the force primarily concerned with gastric emptying, but its potency too, is dependent upon the state of the pylorus. With a relaxed pylorus gastric tonus acts as the essential emptying force. This explains the rapid motility in achlorhydria in the absence of all peristalsis. It is also the force responsible for the rapid motility following the proper neutralization of the gastric contents in a normal or hyperacid stomach because gastric emptying is more rapid in such stomachs even in the presence of decreased gastric peristalsis. In achlorhydria, gastric tonus may operate unhampered if the

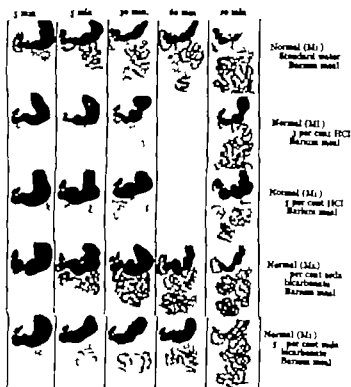


Fig. 2. Response of normal stomach to test substances using mouth meal.

meal administered is of such physicochemical composition as to be acceptable to the duodenum without the stimulation of the duodenopyloric reflex. Under such conditions the pylorus remains open permitting gastric tonus to exert a constant positive force in gastric emptying. With the proper neutralization in an acid stomach the duodenopyloric reflex is again abolished in part or in whole as we have shown thus again permitting gastric tonus to operate against a patent pylorus. It would seem that the same reciprocal relationship exists between gastric tonus and pyloric tonus as has been suggested for gastric peristalsis and pyloric contraction. Marbaix in one series of experiments, after moderately filling a dog's stomach with milk determined the positive tension so produced. He then introduced into the upper intestine through a fistula a quantity of milk sufficient to produce pyloric closure. A new quantity of milk was then instilled into the stomach. Marbaix noted that the intragastric pressure which had been high

during the introduction of the second gastric portion of milk fell rapidly. Similar results had been recorded previously by Kelling and Mordt.

#### ANALYSIS OF PREVIOUS LITERATURE, WITH EXPERIMENTAL DATA ON THE VON MERING REPLETION THEORY

The duodenum as a factor in the control of gastric emptying was first suggested in the early nineties when Hirsch (20) and von Mering reported their studies on dogs with duodenal fistulas. Before these investigators gastric emptying was believed to result from stimuli acting solely within the stomach. The accepted concept of the period is to be found in the splendid monograph of Poensagen, written about 10 years earlier. Investigators seemed generally to agree that the pylorus closed completely during the first period of digestion. Sooner or later simultaneously with the increase in peristalsis, the pylorus relaxed more or less completely to permit passage of the

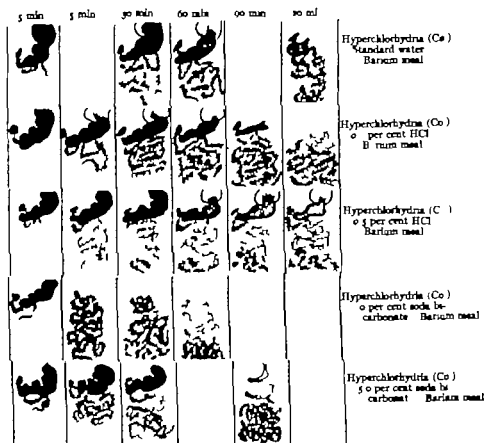


Fig. 3 Response of hyperchlorhydric stomach to test substances using mouth meal.

chymified food. Nothing definite was known of the time between the ingestion and the opening of the pylorus—a period as great as 3 hours having been suggested.

Von Mering showed from studies on dogs with high duodenal fistulas (5 centimeters from the pylorus) that the stomach emptied a standard amount of water more rapidly when the fistula was open. Under such conditions the gastric contents entering the duodenum were permitted to escape to the outside instead of remaining in the duodenum—a result easily understood from our discussions and data heretofore given.

Subsequently, von Mering introduced 250 cubic centimeters of warm milk into the duodenum through the fistula, taking 15 minutes for the operation. He then instilled into the stomach a water meal similar to those previously employed (500 cubic centimeters). His results showed that in the 30 minutes following (the time usually taken by the stomach to evacuate completely such a meal) only a few cubic centimeters of water had left the

stomach. From these and similar observations, von Mering concluded very definitely that “die Anfuellung des Duennndarmes reflectorisch die Entleerung des Magens verlangsamt”<sup>1</sup>. He thus attributes to duodenal repletion the responsibility for delaying gastric emptying. This conclusion influenced the work of Hirsch to a great extent and was supported by Marbaix and apparently by the work of Tobler. The latter was able to cause pyloric closure and a cessation of the rhythmic gastric movements by the mechanical effect of inflating a small balloon in the duodenum. Pavlov was willing on the basis of Tobler's experiments, to accept duodenal distention as a factor in pyloric closure. We believe however that Walter Cannon (5) raised the logical objection to the value of Tobler's experiments as a means of interpreting normal physiology. Dr Cannon points out that chyme normally gathers in the duodenum in a gradual manner by repeated small additions.

<sup>1</sup> The filling of the small intestine reflexly slows the emptying of the stomach.

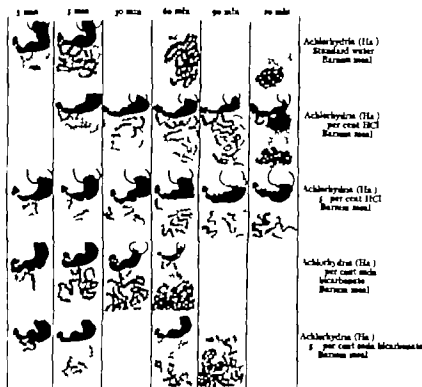


Fig. 4. Response of achlorhydric stomach to test substances using mouth meal.

Such material even when accumulated lies as a slender strand which does not distend the gut—a fact borne out in the daily experience of the roentgenologist during the course of gastro-intestinal examinations. It is obvious therefore that the abnormal situation produced by Tobler's balloon cannot be accepted as portraying normal conditions.

However von Menning is not without support from recent investigators. Kaestle, Rieder and Rosenthal supported by the work of Cole (8) believe that the emptying of the stomach is in large measure dependent upon the emptiness of the duodenum and upper intestine.

We have performed numerous experiments with milk cream etc. as mentioned and believe that our data clearly show that duodenal filling is not of any consequence normally in delaying gastric emptying. Administering by mouth a 250 cubic centimeter meal of milk and barium or cream and barium resulted in a 40 to 70 per cent gastric motor delay with the milk and a delay of over 90 per cent with the

cream, as compared with the emptying of the standard water and barium meal. Delay was as marked in achlorhydria as in patients with normal or excessive amounts of free gastric acid. The gastric delay cannot therefore be attributed to the mechanical effects of the rapid curdling produced in the acid containing stomachs.

The direct duodenal instillation of milk and of cream evoked a duodenopyloric reflex that was equalled only by the action of the stronger acid solutions. Thus the instillation of milk at the rate of 60 drops per minute intraduodenally resulted in a 95 per cent gastric retention of standard water and barium meal taken by mouth. At another time the instillation of milk at the rate of 30 drops per minute resulted in relatively lessened gastric motor delay. However the substitution of table cream for milk resulted in a complete retardation of gastric emptying while the cream was entering the duodenum. The rate of instillation of the cream had been reduced to the very slow 10 to 15 drops per minute amounts that certainly

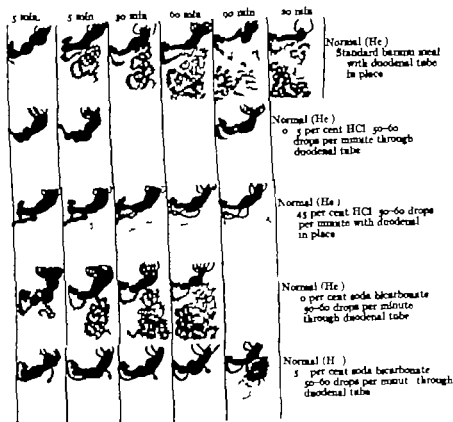


Fig. 5. Response of normal stomach to test substances during duodenal instillation.

could not produce duodenal repletion. In all of our tests we used Abbott's AA milk and table cream, the compositions of which show important differences only in the fat and water content. The milk has approximately 4.8 per cent fat and 86 per cent water, while the cream contains 22 per cent fat and about 70.5 per cent of water. The relationship of the fat content to gastric emptying we shall discuss in a subsequent paper. For our present purpose it suffices that the cream introduced directly into the duodenum in one fifth or one sixth the volume per unit of time at which the milk was introduced produced as great or greater gastric retardation. With the differences in composition noted it is patent that the fat content was the deciding factor in this influence. To test further for the effect of duodenal repletion we substituted normal saline, an agent which we knew was, *per se*, without effect upon gastric emptying. This was run into the duodenum at the rate of 150 drops per minute—a very rapid rate compared with the rate of the introduction of the cream. No delay in gastric emptying was observed with

the normal saline experiments. Although Marbaix in repeating von Mering's experiments, found that he was able to obtain as marked inhibitory effects on gastric emptying with much smaller quantities of milk than von Mering had used, he still attributed the reflex to intestinal filling.

In the same year (1892) that von Mering's contribution appeared, Hirsch (21) reported the first of his studies relating to this problem. It is interesting to note that both men were concerned primarily with the study of absorption by the stomach and only incidentally with the pylorus and its control. In this first publication Hirsch concludes that the liquefaction of the stomach contents is to be regarded as essential to the opening of the pylorus. In the following year he (22) reported the results of his first studies of the effect of acids and alkalis on gastric evacuation. He found that 300 or 400 cubic centimeters quantities of distilled water or tap water, introduced into a dog's stomach were evacuated in from 10 to 20 minutes. He reported similar results with 0.35 per cent, 0.53 per cent, and 1

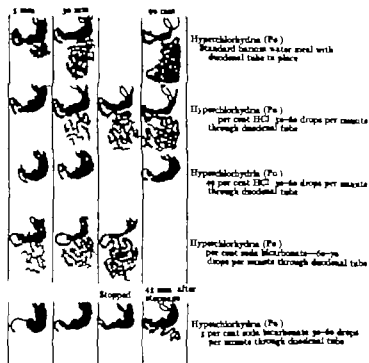


Fig. 6. Response of hyperchlorhydric stomach to test substances during duodenal instillation.

per cent solutions of sodium bicarbonate. But 0.1 per cent to 0.2 per cent solutions of hydrochloric acid he found were markedly retarded and still greater gastric delay was obtained with 0.3 per cent and 0.5 per cent solutions of the acid. In his acid experiments he often recovered 150 to 200 cubic centimeters more from the stomach than the amount which he had instilled. From this series of experiments, Hirsch believed that it was possible that the effects of the various strengths of acid were due more to differences in the secretion stimulated than to changes in evacuation. He concludes that the pylorus is not influenced in any way with respect to its opening and closing by alkaline, neutral, or acid fluids and that these functions cannot, therefore, be dependent upon the reactions of the fluids in the stomach. Hirsch states that it seems much more likely that the movements of the pylorus are dependent upon the movements of the stomach, the latter in their turn being dependent upon stimuli affecting the entire gastric mucosa. It is only in his succeeding article (20) in which

he studies the relative rates of emptying of several inorganic and organic acids, that he concludes somewhat abruptly that the emptying of the stomach is influenced by the action of the acids on the intestinal mucosa.

We have discussed the contributions of von Mering and of Hirsch at some length because of their historical interest and because of the importance of their observations to our own study. Subsequent literature has referred to the duodenal effect on gastric emptying as the Hirsch von Mering reflex. From an analysis of their reports, however, it is apparent that neither of them clearly appreciated the mechanism involved nor its importance in gastric emptying. Serdjukov a few years after them was the first to do so.

Working under Pavlov Serdjukov in his doctor's thesis elucidated this problem to a far greater degree than either of his predecessors. He experimented with dogs which, in addition to a chronic gastric fistula, had fistulas of the pancreatic duct, of the duodenum, or of the esophagus. He recorded 365 experi-

ments made upon 11 dogs. As a measure of gastric motility he recorded the amount of contents recoverable through the gastric fistula at a given time following the introduction of standard amounts of the test substances. These were neutral water, 0.25 per cent and 0.5 per cent sodium bicarbonate solutions, similar strengths of hydrochloric acid, and the normal gastric juice of other dogs. Serdjukov could detect no appreciable difference in the velocity with which the stomach emptied the water, acid, or alkali, although in general his impression was that the alkali drained faster.

In dogs that had in addition to the gastric fistula an external pancreatic fistula of the main pancreatic duct, decidedly different results were obtained. In these animals the acid solutions were stubbornly retained in the stomach, while the alkaline ones left very rapidly. From these experiments, Serdjukov looked upon the hydrochloric acid as the specific agent in the inauguration of the pyloric reflex. He then logically reasoned that if this were the case it should be possible to produce an artificial, prolonged closure of the pylorus by the systematic irritation with acid of the mucous surface of the duodenum. Accordingly, he introduced into the duodenum, on different occasions, both acid solutions and the acid gastric juice of another dog. He was thus able to retard the emptying of the stomach not only of the acids but also of the alkaline solutions, which normally left very rapidly. To offset any objections to his results by the argument that the gastric motor delay was due to the mechanical irritation of the duodenum during the manipulation, he repeated the experiments upon the same dog substituting a 0.25 per cent bicarbonate solution for the acid or acid juice. Such a solution produced no gastric delay. Serdjukov concluded that the alkali introduced into the duodenum through its fistula "invited," as it were, the contents of the stomach. It is unfortunate that work so well conceived and executed should have suffered because of the limitations of the solutions used. Had he not restricted himself to the concentrations of the solutions he did, he would not have been misled into believing that hydrochloric acid is the specific agent capable of initiating the duodenopyloric reflex.

Lantvarev, another pupil of Pavlov, while primarily studying this problem in its relation to the action of fats, repeated some of the above experiments. He used the gastric juice of another dog as the duodenal stimulant, in preference to the acid solutions. Lantvarev further tried to study the duration of the pyloric reflex produced by duodenal stimulation. He concluded that the reflex occurred very rapidly but diminished as soon as the acid was neutralized by the intestinal secretions and was completely eliminated in from 40 to 45 minutes. These effects were obtained after the introduction of only 25 cubic centimeters of gastric juice into the duodenum. Our own observations in human beings after an extended introduction of acid and other agents into the duodenum showed no greater prolongation of the reflex. Even after 200 to 300 cubic centimeters of the test agent had been introduced normal gastric motility was usually re-established 30 to 45 minutes after the cessation of the instillation.

All experimental work concerned with the duodenopyloric reflex as conceived by Hirsch and von Mering came practically to a standstill at the end of the past century. The reason for this becomes apparent when we remember that it was at this time that the work of Walter Cannon began to be known and that at about this time too, came the introduction of a new and spectacular method of investigation—the X ray. These factors coupled with Dr. Cannon's forceful logic soon overshadowed all antecedent contributions to the study of the physiology of the pylorus. More recently, owing to some shortcomings in the Cannon theory, numerous studies of the effects of acids and alkalis upon pyloric action have been made. However, in regard to the action of these chemicals no unanimity of opinion has thus far been achieved.

Tabora in 1911 investigated normal individuals with the X ray. He studied peristalsis and the gastric evacuation time in individuals with normal, increased, and decreased acid secretions after their ingestion of bismuth broth alone, after bismuth with hydrochloric acid, and after bismuth with oil. Unfortunately, there exists no record of the strength of acid or oil that he used. His results showed a



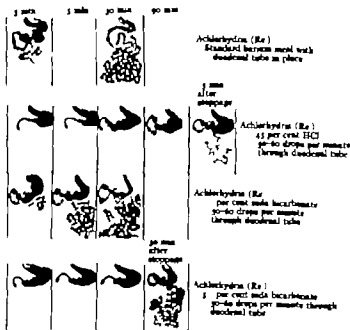


Fig. 7. Response of achyloric stomach to test substances during duodenal instillation.

marked retardation of gastric emptying after the addition of the acid to the meal. The average evacuation time was increased by about 50 per cent. During that same year Cowie and Lyon observed gastric motor delay in infants, following the addition of acid or alkali to the meal. Ladd, on the contrary was able to hasten gastric discharge in infants by alkalizing the food with sodium bicarbonate. Spencer Meyer Rehfuess, and Hawk, determining gastric emptying in adults by means of the stomach tube reported results similar to those of Ladd. Degener using methods similar to those of Spencer *et al* achieved like results.

Interesting indirect evidence of the effect of acid on gastric emptying was obtained by Ivy from studies in water drinking in man. He noted that the stimulating power of water for the production of gastric secretion varied noticeably in different individuals. He observed further that the stomach which emptied the water quickly did not respond to stimulation by water. Finally the work of McClure, Reynolds, and Schwartz presents the most recent serious attempt to study this

problem in human beings. They observed fluoroscopically among other things the effect of the application of hydrochloric acid and bicarbonate of soda solutions through a tube to the antral and duodenal sides of the sphincter. They noticed no effect upon the opening or closure of the pylorus following the repeated introduction of 10 to 20 cubic centimeter portions of tenth normal hydrochloric acid on the antral side of the sphincter. Similar results were obtained with 1 per cent and 5 per cent bicarbonate. After the introduction of 20 cubic centimeters of tenth normal hydrochloric acid into the first portion of the duodenum, they recorded in two instances duodenal antiperistalsis, associated with either prolonged pylorospasm or almost complete cessation of antral peristalsis.

It is obvious from the results obtained from our experiments that McClure *et al* failed to obtain an effect from antral applications because the small quantities of reagent which they used at any one time were neutralized or diluted before a proper concentration reached the duodenum to activate the duodenopyloric reflex.

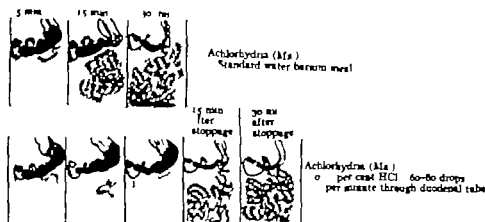


Fig. 8. Response of *achlorhydric* stomach to test substances during duodenal instillation

The conflict of the evidence from human experimentation is not lacking in the results from animal experiments—in which latter case conditions are supposed to be more easily controlled. Just preceding Serdjukov, there appeared in France an extensive article by Marbaix. It includes an exhaustive historical review which frequently seems impertinent to the subject. But it does contain additional experimental data. Marbaix started with the supposition that the intestine influences the action of the pylorus. He attempted in his studies on dogs with intestinal fistulas to determine the extent of intestinal mucosa from which this influence could be elicited. He placed one fistula at 10 to 15 centimeters distant from the pylorus at which level he knew he could induce the reflex. A second fistula was placed at varying points distal to the first. In 4 dogs the second fistula was located at 28 centimeters proximal to the caecum, a little above this in the middle of the intestine about 1.3 meters from the pylorus, above the first quarter of the intestine (48 centimeters from the pylorus), and 25 centimeters from the pylorus, respectively.

In the first and second dogs the introduction of milk through the lower fistula failed of any effect upon gastric emptying. In the 2 others however, gastric motor delay resulted when the milk was similarly applied. Marbaix concluded in this chapter that the influence of intestinal filling on the closure of the pylorus is manifest within the upper half of the small intestine. The lower half seems scarcely to possess such an effect. Marbaix

states cautiously that he does not wish to be misunderstood as excluding all influence from the lower portion of the intestine. He is content to say that the difference in their influence upon pyloric control between the two halves of the small intestine is very marked. Marbaix like von Mering before him, had failed to grasp the significance of the action of the *milk* in initiating the intestinal reflex and so attributed it to intestinal filling.

Likewise, we in our experiments on human beings attempted to determine the extent of the mucosa from which an influence on the pylorus could be elicited. Thus far our efforts have been but partially rewarded. By the use of long duodenal tubes we were able to reach the upper jejunum. In one instance we studied the effects of various substances introduced into the lower ileum through the ileostomy opening in a patient who had had a complete colectomy. Unfortunately the skin surrounding the ileal opening was so sensitive that we were unable to eliminate psychic factors and their effects upon gastric motility.

In one series in which we used as the intestinal stimulant through the long duodenal tube a 10 per cent (hypertonic) glucose solution, we obtained a 30 per cent increase in gastric residue as compared with the patient's standard gastric emptying. The glucose was instilled at the comparatively low rate of 40 drops per minute and the tip of the tube was approximately at the junction of the second and third portions of the duodenum. A similar result was obtained when the tip of the tube was in the upper jejunum. Thus far we feel justified

in the belief that the border patrol against the admission of the irritant lies in the region of the apex of the duodenal cap but our intestinal intubation studies show that the reflex for pyloric closure may also be elicited by stimuli affecting the intestinal mucosa for a considerable distance beyond this area.

Certain other interesting phenomena were noted. Gaskell deduced that the pyloric sphincter has a special nerve supply different from that of the stomach and duodenum. Recent opinion (8, 31, 34) however has inclined to the view that all of the muscle of the pyloric portion of the stomach including the sphincter is a single functional unit. Cole (9) was the first to advance the theory that the duodenal cap is functionally part of the stomach. Several years later Thomas and Wheelon found that in every instance in which they obtained simultaneous records showing the effect of stimulating the extrinsic nerves to the antrum sphincter and first part of the duodenum all three responded in the same way. More recently McCrea and McSwiney have shown that the reaction of the pyloric antrum need not necessarily follow the response of the rest of the stomach to nerve stimulation, and Brown, McSwiney and Wadge (2) were unable to obtain motor response in the pyloric antrum of the cat, even when the body of the stomach showed contraction readily. In a later study on spinal cats, Brown and McSwiney (1) were able to show marked differences in the response of the pyloric antrum and the remainder of the stomach following the administration of luminal and sympathetic stimulation. In spinal cats sympathetic stimulation caused gastric inhibition. In the spinal animal under the effects of luminal sympathetic stimulation results in a complete reversal of the usual inhibitory reaction. The reaction of the pyloric antrum remained the same, however under the influence of luminal. When spontaneous movements of the antrum were present, the effect of sympathetic stimulation was invariably inhibitory differing in no way from the reactions observed in the spinal cat without anesthetic. Many of our observations indicate that the antrum, pylorus, and duodenal cap are probably more closely related as a functional unit than is the an-

trum to the body of the stomach or the cap to the adjacent duodenum. In our experiments involving the administration of the test substances by mouth occasional instances of antral spasm as well as pylorospasm were noted with the more active reagents. This occurred, though, only in the achlorhydrics. The duodenal instillations, however were productive of many more examples of this combined spasm which were manifested with the weaker acid solutions as well as with the 5 per cent bicarbonate. Antral spasm was obtained in this case in patients with acid secretions as well as in achlorhydrics. The antral spasm thus appears to be linked up with the duodenal reflex, but its production is apparently related to the intensity of the duodenal stimulus and to the spread of the impulse.

Returning to previous animal experimentation, we find that Schuele a contemporary of Hirsch and von Mering concluded from studies on duodenal fistula dogs, that sodium bicarbonate hastened the emptying of the stomach. He attributed the change in motility to the action of the liberated carbon dioxide. He grounded his opinion in the results of Kusmann (28) that insufflation of carbon dioxide into the stomach markedly increased gastric peristalsis, and of Jaworski that carbon dioxide hastened gastric evacuation.

Morse found that water was discharged from the fasting stomach of anesthetized pithed dogs faster than any percentage of acid. The most prominent feature he observed was the progressive diminution in the rapidity of discharge as compared with the increase in the acidity. These results are in keeping with our observations on human subjects. They fail to confirm the results of Hedblom and Cannon that acidities up to 0.25 per cent hasten motility that 0.5 per cent acid has relatively no effect upon motility at least during the first half hour and that motility is not slowed materially until 1 per cent acid meals are used. Ortnor following evacuation in dogs having a Dastre cannula in the duodenum a few centimeters below the pylorus, observed that alkaline water passed from the stomach sooner than did acid. Strong acid (above 0.3 per cent hydrochloric) distinctly inhibited the relaxation of the pyloric sphincter. Ortnor

colored his test meal with methylene blue and used the appearance time of the blue color in the duodenum as a measure of the time necessary for pyloric opening. Marks, in duodenal fistula dogs, found a progressive delay in gastric emptying dependent upon an increasing acidity of the administered meal. Recently, Stewart and Boldyreff, working with gastric fistula dogs, reported that a 0.5 per cent solution of hydrochloric acid left the stomach at one third the rate of an equal quantity of water. They found that alkalis, with the exception of weak solutions (0.5 to 1 per cent), produced marked inhibition of gastric emptying.

We have never observed in human beings the phenomena reported for dogs by Mogan and Thomas. They report as the predominant effect of hydrochloric acid in the duodenum, a decrease in the extent and constancy of the pyloric contractions. They regard this inhibitory effect upon the sphincter as probably incidental to a general inhibition of the stomach.

Elman and Rowlette studied the gastric emptying time and acidity curves in dogs in which the pyloric sphincter had been cut across and to the submucosa. They found that postoperative gastric emptying of a 200 cubic centimeter meal of 0.5 per cent hydrochloric acid was more rapid than that which occurred before the operation. That this change in motility is due to the greater accessibility of the stomach to the duodenal contents is untenable in the light of recent experiments (48). A more likely explanation is available as a result of our present studies. Applied to the data of Elman and Rowlette we should expect an imperfect response to the duodenal reflex of a sphincter muscle impaired by cutting which should, therefore, permit of more rapid gastric emptying. The beneficial effects in the treatment of duodenal ulcers, recently reported by Deaver and Burden, from resection of the anterior half of the pyloric sphincter are in all likelihood dependent upon a similar explanation, rather than upon the increased duodenal reflux, as suggested.

Of all the animal experiments reported those of Carlson and Litt most closely parallel our results in humans. They recorded pyloric action in dogs by means of a balloon. They

were also able to apply reagents to the gastric and duodenal sides of the pylorus. They found that unless the pylorus was already in hypertonus and spasm they never failed to secure contractions of the pylorus from anything and everything that stimulated the nerve endings in the duodenal mucosa. They recorded that the stronger the acid or alkali used, the stronger and more prolonged was the induced pylorospasm. The same substances acting in the stomach caused neither relaxation nor contraction of the pylorus. Carlson and Litt also observed effects upon the pylorus from the duodenal introduction of water. This holds true in the human subject as well because we obtained a more rapid gastric evacuation of the mouth barium meal during the intraduodenal instillation of normal saline as compared with that obtained during the instillation of plain water.

#### SUMMARY AND CONCLUSIONS

We have indicated briefly to what extent the rôle of the pylorus has engaged the attention of medical thought even before the dawn of experimental physiology. That this interest has been maintained is reflected in the ever changing nomenclature successively applied to this muscular strip.

Our own experiments have consisted of a roentgenological study of gastric emptying and pyloric behavior in human subjects following the gastric and duodenal application of various test substances. While many reagents were studied this report is primarily concerned with the action of acid and alkali in 176 serial roentgen examinations which indicate that

- 1 Without due consideration of the individual gastric secretory response no proper evaluation of the experimental results could be made.

- 2 Of the three components concerned in gastric emptying, gastric peristalsis plays an incidental rôle only and is not concerned with pyloric opening, gastric tonus is the greater motivating force, but the potency of each depends entirely upon the state of the pylorus.

- 3 When the stomach is empty, the normal state of the pylorus is that of relaxation. This is always seen in achlorhydrics, but does not obtain in patients with free gastric acid.

4. The hydrochloric acid of the gastric contents is the natural intrinsic agent responsible for pyloric action. We do not imply however that it is the sole possible agent. Certain other ingested substances, such as various irritants, fats, hypertonic or hypotonic solutions of sugars and neutral salts through their chemical or physical action are equally efficacious.

5. Any agent (intrinsic or extrinsic) becomes effective in producing pyloric closure only upon reaching the duodenum. Here a reflex is activated and maintained until proper neutralization or dilution of the duodenal contents which makes it acceptable to the adjacent distal duodenum, has occurred. Then pyloric relaxation.

6. The duodenal mucosa adjacent to the cap is most responsive to stimulation though the response may be obtained in other portions as well. In general, the farther from the cap the stronger the stimulus necessary to evoke pyloric response.

7. Under normal conditions, the duodenopyloric reflex is not dependent upon duodenal filling.

8. Evidence is presented suggesting that the duodenal neutralizing mechanism is most highly developed in hyperchlorhydria and least in achlorhydria.

9. The antrum, pylorus and duodenal cap appear physiologically to be intimately related. Were we to picture our concept of pyloric action in a homely simile, as others have been wont to do we would say that the stomach is like a dumbwaiter ever ready to deliver through its door the pylorus anything reaching it. The duodenum however sensitive connoisseur is selective. If the gastric contents are acceptable to the official taster the duodenal cap gastric emptying continues uninterrupted. If not the door or pylorus is hurriedly closed and stays so until the portion tasted trial portion is rendered acceptable. Thus, we see the pylorus as a door—emphatically not autonomous.

NOTE.—We are greatly indebted to M. Eugene Golomastak of the Staff of the Museum of University of Pennsylvania for complete translations of the monographs of references 30 and 47.

## BIBLIOGRAPHY

1. BROWN, G. L. and McSWINEY, A. B. The sympathetic innervation of the stomach. Review of sympathetic action by lumbar. *J. Physiol.*, 1932, lxxv, 179.
2. BROWN, G. L., McSWINEY, A. B., and WADGE, W. J. The effect on the stomach of stimulation of the thoracic sympathetic trunk. *J. Physiol.*, 1930, lxx, 453.
3. BRUNSWICK, E. H., and CARLSON, A. J. Reflexes from the intestinal mucosa to the stomach. *Am. J. Physiol.*, 9, 5, xxxiv, 19.
4. CARLSON, W. B. The movements of the stomach studied by means of the roentgen ray. *Am. J. Physiol.*, 38, 1, 359.
5. Idem. The movements of the intestines studied by means of the roentgen ray. *Am. J. Physiol.*, 190, vi, 302.
6. CARLSON, A. J. and LITT, S. Studies on the visceral nervous system. On the reflex control of the pylorus. *Arch. Int. Med.*, 94, xxxiii, 251.
7. COLE, LUTHER GILBERT. A radiographic study of the pylorus and duodenum, with and without artificial dilatation of the duodenum. *Arch. Roentgen Ray*, 19, -1912, xvi, 435.
8. Idem. Physiology of the pylorus, pilorus ventriculi, and duodenum as observed roentgenographically. *J. Am. M. Ass.*, 1913, lxi, 762.
9. Idem. Motor phenomenon of the stomach, pylorus and cap observed roentgenographically. *Am. J. Physiol.*, 19, 7, xlii, 618.
10. COOPER, GEORGE W. *Anatomia Partu Cephala in Anatomical Texts of the Earlier Middle Ages*, p. 49. Washington, D. C. Carnegie Institution, 1927.
11. COWIE, D. M., and LAYNE, W. Further observations of the acid control of the pylorus in infants. *Am. J. Dis. Child.*, 19, ii, 52.
12. DRAVER, J. B. and BURGER, V. G. The pyloric sphincter and duodenal ulcer. *Ann. Surg.*, 1931, xiv, 818.
13. DEGENHARD, M. U. Untersuchungen über den Einfluss von Alkalien auf Mithotakt und Sekretion des Magens mittels der Fraktionierten Ausbeurteilung. *Munch. med. Wchnsch.*, 92, lxxv, 838.
14. D'EMILIO, RUDOLPH. *Œuvres de*, translated by Charles Darnenberg, p. 57 line 68. Paris. L'Imprimerie Nationale, 879.
15. ELMAN, R., and ROWLETT, A. P. The rôle of the pyloric sphincter in the behavior of gastric acidity. *Arch. Surg.*, 93, xvi, 426.
16. GALEPPE, CLAUDE. *Opera Omnia*, edited by D. C. G. Kuhn Vol. III, p. 280. Leipzig, 821.
17. GIBBELL, W. H. *The Involuntary System*. London Longmans, Green & Co., 1906.
18. HÄNDEL, A. O. In estigations into the secretion of gastric juice in healthy persons. *Acta med. Scand.*, 1924, Supp. 7, 228.
19. HEDGECOCK, C. A. and CARLSON, W. B. Some conditions affecting the discharge of food from the stomach. *Am. J. M. Sc.*, 900, xxxviii, 904.
20. HINCH, A. Weitere Beiträge zur motorischen Funktion des Magens nach Versuchen an Hunden mit Darmfisteln. *Centralbl. f. klin. Med.*, 89, xiv, 377.
21. Idem. Beiträge zur motorischen Funktion des Magens beim Hunde. *Centralbl. f. klin. Med.*, 94, xiii, 993.
22. Idem. Untersuchungen über den Einfluss von Alkali und Säure auf die motorischen Funktionen des Hundmagens. *Centralbl. f. klin. Med.*, 89, xv, 73.

23. IRY A. C. Contributions to the physiology of the stomach studies in water drinking. *Am. J. Physiol.* 1918, xlv, 420.
24. JAWORSKI, W. Vergleichende experimentelle Untersuchungen ueber das Verhalten des Kissinger und Karlsbader Wassers, sowie des Karlsbader Quellwassers im Menschlichen Magen. *Deutsch. Arch. f. klin. Med.*, 1884, xxxv, 28.
25. KASTRIZ, C. RIECKER, H. and ROSENTHAL, J. The biocentogenography of the internal organs. *Arch. Roentgenol.* 1910, xv, 3.
26. KELLING and MORITZ. Quoted by Marbach.
27. KUMMEL, A. Ueber die Behandlung der Magenerweiterung durch eine neue Methode mittelst der Magenpumpe. *Arch. f. klin. Med.* 1869, vi, 455.
28. Idem. Die peristaltische Unruhe des Magens, nebst Bemerkungen ueber Tiefstand und Erweiterung desselben, das Klatschgeraesch und Galle im Magen. *Samml. klin. Vortr.* 1880, cxxxix, 1673.
29. LADD, M. The influence of alkalis upon gastric motility. *Boston M. & S. J.* 1914, clxx, 518.
30. LUDWIG, S. I. The rôle of fats in the passage of the stomach contents into the intestine. *Diss. Imperial Academy St. Petersburg* 1901 No. 8. (In Russian.)
31. LOCKHART A. B., PHILLIPS, H. I. and CARLSON A. J. Contributions to the physiology of the stomach control of pylorus. *Am. J. Physiol.* 1919, l, 57.
32. MARBACH, O. Le Passage Pylorique. *Cellule*, 1898, xv, 249.
33. MARIX, J. Ueber den Einfluss der Salzsäure auf die Magenentleerung. *Arch. f. Verdauungskr.* 1918, xlii, 569.
34. McCLURE, C. W. REYNOLDS, L. and SCHWARTZ, C. O. On the behavior of the pyloric sphincter in normal man. *Arch. Int. Med.* 1920, xxvi, 410.
35. MCCREA, E. D. and MCSWINEY A. B. The effect of stimulation of the vagi on the pyloric region of the stomach. *J. Physiol.* 1916, lxi, 28.
36. MOGAM, C. J. and THOMAS, J. E. The effect on the pyloric sphincter of acid in the stomach and in the duodenum. *Am. J. Physiol.* 1931, xcvi, 546.
37. MORSE, W. E. The relation of acid to gastric discharge and duodenal regurgitation in the dog. *Am. J. Physiol.*, 1916, xli, 439.
38. OPPENHEIMER, Z. Ueber die motorischen Verrichtungen des Magens. *Deutsche med. Wchnschr.* 1889, xv, 135.
39. ORTNER, A. Ein Beitrag zur Kenntnis der Magenentleerung und ihrer Beziehung zur Verdauungsekretion des Magens. *Arch. f. d. ges. Physiol.* 1917, clxviii, 124.
40. PAYLOV, L. P. The Work of the Digestive Glands. P. 186. London: Charles Griffin & Co. 1910.
41. PRINCE, PHILLIP SYMO. An account of a new mode of extracting poisonous substances from the stomach. *Elect. Repertory & Analytical Rev.*, 1812, lli, 11.
42. POENSCHE, E. Die motorischen Verrichtungen des menschlichen Magens und ihre Störungen. p. 73. Strassburg: Karl J. Trubner, 1882.
43. RICHIERAND A. B. *Nouveaux Eléments de Physiologie*. p. 243 9th ed. 1835.
44. ROSENTHAL, M. J. Beiträge zur Lehre von den Bewegungen des Magens, Pylorus, und Duodenum. *Deutsche Arch. f. klin. Med.* 1890, xli, 296.
45. ROUX, J. CH. and BALHAZARD, M. Note Sur les Fonctions Motrices del Estomac du Chien. *Compt. Rend. Soc. de Biol.* 1897, iv, 705.
46. SCHUFFLE, A. Untersuchungen ueber die Sekretion und Motilität des Normalen Magens. *Ztschr. f. klin. Med.* 1896, xxix, 49.
47. SERDJUKOV, A. S. One of the important conditions for the passage of food from the stomach to the intestine. *Dissertation. St. Petersburg* No. 47 1898-1899. (In Russian.)
48. SHAY, H. KATZ, A. B. and SCHLOSS, E. M. Experimental studies in gastric physiology. I. Evaluation of the rôle of duodenal regurgitation in the control of gastric acidity in man. (Baldyreff theory). *Arch. Int. Med.* 1932, l, 605.
49. SPENCER, W. H., MEYER, G. P. REHRUSS, M. E., and HAWK, P. B. Direct evidence of duodenal regurgitation and its influences upon the chemistry and function of the normal human stomach. *Am. J. Physiol.*, 1915, xxxix, 459.
50. STARRING, E. H. *Recent Advances in the Physiology of Digestion*. Chicago: W. T. Keene & Co. 1907.
51. STEWART, J. F. and BOLDYREFF, W. N. Factors influencing the passage of liquids from the stomach into the intestine. *Am. J. Physiol.* 1932, cii, 276.
52. TABORA, D. Ueber motorische Magenreflexe. *Verhandl. d. deutsch. Kong. f. innere Med.* 1911, xxviii, 378.
53. THOMAS, J. E. and WHEELON, H. The nervous control of the pyloric sphincter. *J. Lab. & Clin. Med.* 1922, vii, 375.
54. TORLIER, L. Ueber die Erweisverdaunung im Magen. *Ztschr. f. Physiol. Chem.* 1905, xlv, 185.
55. VAN HELMONT, J. B. *Ortus Medicinæ* Klat. Initia Physicæ Inaudita. p. 181 1653. Quoted by Poenschen.
56. VON MIERING, J. Ueber die Funktion des Magens. *Verhandl. d. Kong. f. innere Med.* 1895, xli, 471.
57. VON MORITZ, J. Studien ueber die motorische Tätigkeit des Magens. *Ztschr. f. Biol.* 1901, xlii, 595.
58. WHEELON, H., and THOMAS, J. E. Observations on the motility of the duodenum and the relation of the duodenal activity to that of the pars pylorica. *Am. J. Physiol.* 1922, lix, 72. Observations on the motility of the antrum and the relation of rhythmic activity of the pyloric sphincter to that of the antrum. *J. Lab. & Clin. Med.* 1920, vi, 124.

## GASTRIC LAVAGE IN THE TREATMENT OF PYLORIC OBSTRUCTION

AN EXPERIMENTAL STUDY<sup>1</sup>

NORMAN E. FREEMAN M.D. AND ROBERT L. BROWN M.D., BOSTON

IN the course of studies on the gastric secretion of cats following pyloric obstruction daily aspiration of the stomach contents was found to be necessary. To our surprise it was observed that the animals which were subjected to repeated emptying of the stomach survived considerably longer than untreated controls. This investigation was therefore made to determine the factors responsible for the longer survival of the treated animals.

**Methods.** Healthy adult male or non-pregnant female cats were used. They were fed on a mixed diet of meat and milk but had fasted for 24 hours before the experiment was begun. Before operation a tube was passed the gastric contents aspirated, and the stomach washed until clean with distilled water. Under ether anaesthesia, through a midline incision a rubber band  $\frac{3}{4}$  inch wide was passed under the duodenum between the pylorus and the common duct and was tied just sufficiently to cause blanching of the wall of the gut. The urinary bladder was then emptied by gentle pressure. The cats were placed in cages in an isolated room in order to avoid psychic stimulation of gastric secretion (2). They were weighed daily and the rectal temperature was taken. The control animals were not fed but in some of the experiments measured quantities of distilled water were offered. The vomitus was collected for 24 hour periods, though generally there was none until 36 to 48 hours after obstruction. Urine was usually expressed from the bladder daily in order not to contaminate the vomitus. The treated animals had their stomachs emptied and washed out shortly after operation and twice daily thereafter. Urine was collected at 24 hour periods. Careful notes were taken of the general condition of the cats, especially with reference to activity, dehydration, or tetany. At postmortem examination the completeness of the obstruction was verified and the stomach and bladder emp-

tied. In one series of experiments on survival, 6 cats served as controls and 5 others were subjected to repeated gastric lavage. Determinations were made of the loss of fluid, chloride, protein and non protein nitrogen in the gastric contents. In another series of 4 cats the levels of blood chloride, protein and non protein nitrogen were estimated before and again 3 days after obstruction. The blood was taken from the femoral artery under ether anaesthesia. These findings were correlated with the loss by way of the stomach and kidneys. The chloride was determined in the blood, gastric contents and urine as milligrams of sodium chloride by the Van Slyke method as modified by Fiske. The protein of the blood and gastric contents was measured by the micro-Kjeldahl method of Howe after deducting the non protein nitrogen which was estimated by the Folin method.

**Results.** Figure 1 shows the average length of life after pyloric obstruction in 5 cats which were subjected to gastric lavage twice a day in comparison with that of 6 control animals which were not so treated. Emptying the stomach and washing it out allowed the animals to live almost twice as long as those which accumulated their secretions until they vomited. In no case did a cat whose stomach was regularly emptied die sooner than the control animal.

**Protocol 1.** Cat ♀ male, 3500 grams. Fasting 24 hours. The stomach was emptied and washed with 30 cubic centimeters distilled water. Ether anaesthesia was used. A rubber band was tied about the duodenum. The urine was expressed from the bladder. The animal was placed in an isolated cage with 100 cubic centimeters distilled water.

First day. Weight 3370 grams. Rectal temperature 98.3 degrees F. Water intake 90 cubic centimeters. Vomitus 125 cubic centimeters.

Second day. Urine 90 cubic centimeters. Water intake 30 cubic centimeters. No vomitus.

Third day. Animal was found dead in cage. Weight 3000 grams. Water intake 91 cubic centimeters. Urine and vomitus 258 cubic centimeters.

<sup>1</sup>From the Surgical Laboratories of the Harvard Medical School at the Massachusetts General Hospital.

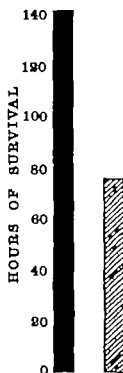


Fig. 1 The average survival after pyloric obstruction of 5 cats (solid block) treated by repeated gastric lavage as compared with the average length of life in 6 untreated animals (cross-hatching)

Postmortem examination revealed a markedly dilated stomach containing 17 cubic centimeters of fluid.

**Protocol 2** Cat 10, male, 3950 grams. Fasting 14 hours. The stomach was emptied and washed with 30 cubic centimeters distilled water. Ether anesthesia was used. A rubber band was tied about the duodenum. The urine was expressed from the bladder. The stomach was emptied and lavaged 1 hour after recovery from anesthesia. Animal was placed in isolated cage.

**First day** Weight 3900 grams. Rectal temperature 97 degrees F. Urine 45 cubic centimeters. The stomach was aspirated, 27 cubic centimeters washed with 60 cubic centimeters distilled water.

**Second day** Weight 3850 grams. Stomach contents, 90 cubic centimeters. Washings, 30 cubic centimeters.

**Third day** Weight 3650 grams. Rectal temperature 98 degrees F. Urine 70 cubic centimeters. Stomach contents 27 cubic centimeters. Washings, 30 cubic centimeters. The cat was very active and ran about the room.

**Fourth day** Weight 3520 grams. Rectal temperature 98 degrees F. Urine 40 cubic centimeters. Stomach contents 20 cubic centimeters. Washings, 30 cubic centimeters. Condition was even better than on day before.

**Fifth day** Weight 3300 grams. Rectal temperature 97 degrees F. Urine 126 cubic centimeters. Stomach contents 8 cubic centimeters. Washings 30 cubic centimeters. Animal was very active, alert, and interested in surroundings.

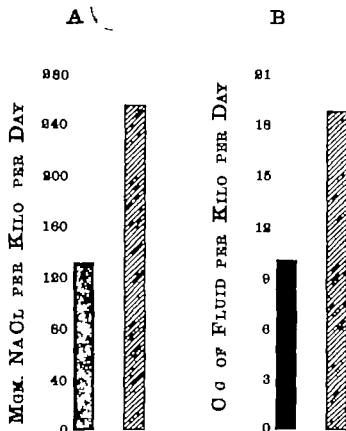


Fig. 2 The average loss of chloride (A) and of water (B) per kilogram per day after pyloric obstruction in 4 cats treated by repeated gastric lavage (solid block) as compared with that in 4 untreated animals (cross-hatching)

**Sixth day** Weight 3150 grams. Stomach contents  $\pm$  1 cubic centimeter. Not washed out. Very dehydrated. Still active.

**Seventh day** Weight 3100 grams. Urine 28 cubic centimeters. Anesthetized with ether, pylorus found tightly closed. The stomach was small and contracted, contents 4 cubic centimeters. Sacrificed.

The average loss of water and chloride per unit of body weight per day was also decreased when gastric lavage was repeatedly performed. Figure 2 illustrates the differences in the average rates of loss in 4 treated in comparison with 4 untreated animals.

The diminished rate of chloride loss was associated with a higher level of chloride in the blood. While the average fall in the chloride level in 5 untreated cats was from 677 to 444 milligrams per 100 cubic centimeters in 3-4 days, in 4 treated cats the average fall was only from 686 to 527 milligrams per 100 cubic centimeters in 4-5 days.

The body temperature during the period of dehydration after pyloric obstruction varied



only within 2.5 degrees F generally being slightly lower at the end of the experiment.

Analyses of the nitrogen of the gastric contents revealed only small quantities of protein 0.25 per cent in an average of 5 experiments. The non protein nitrogen content however increased as the dehydration progressed. In Cat 7 the concentration increased steadily from 74 milligrams on the first day after operation to 400 milligrams per 100 cubic centimeters on the fifth day. No correlation between survival and nitrogen loss was found.

#### COMMENTS

It has been recognized since the work of Gamble and McIver that death after pyloric obstruction is directly referable to the loss of water and electrolytes from the body by way of the stomach. Any factor therefore which hastens the secretion of these substances should lead to an earlier death. It has been shown for example that subcutaneous injection of histamine in dogs with a pyloric fistula results in an increased rate of gastric secretion and leads to a rapid and fatal dehydration and dechlorination (1). Water itself does not stimulate gastric secretion (7). If the stomach is distended, however the outpouring of fluid is definitely increased (7). So also is it stimulated by salts and by nitrogenous substances (7). By repeated gastric lavage in these experiments distention was prevented and any incitants of secretion were removed. The loss of chloride and water was thereby reduced (Fig. 2) and life prolonged in the treated animals (Fig. 1).

Gastric lavage has been used clinically for some years. The work of Wangensteen has placed great emphasis upon the comfort and relief from distention and vomiting to be obtained from drainage of the stomach by the nasal tube. He states that it has been remarkable how the patient's condition as well as his comfort improved incident to the interruption of accretion in distention (9).

The results obtained in these experiments would seem to indicate that the improvement in general condition after gastric lavage was due at least in part to a reduction in the rate of loss of water and electrolytes from the body into the lumen of the stomach.

#### CONCLUSIONS

1. The period of survival in cats with complete pyloric obstruction is almost doubled by frequent aspiration of the stomach contents.
2. There is a concomitant decrease in the rate of loss of chloride and water in the treated animals.
3. The loss of protein by way of the stomach is quite small.
4. Dehydration from pyloric obstruction in cats is not associated with an elevation of body temperature.
5. It is suggested that in clinical cases the benefit derived from gastric lavage is to be attributed in part to the decrease in the rate of loss of chloride and fluid from the body into the stomach.

#### BIBLIOGRAPHY

- ANDRUS, W. D., GURLEY, O. M., GARDER, R. F. and ARSLY, A. Chemical studies of the blood in high intestinal obstruction. *J. Clin. Invest.*, 1937, 16, 475.
- CARLSON, A. J., OHL, J. S., and HENDERMAN, W. F. Psychic stimulation has been shown to increase gastric secretion in cats. *Am. J. Physiol.*, 1914, 22, 81, 86.
- FERRE, C. H. Personal communication.
- FOLIN, O. The proteins were first precipitated by Folin's method. *J. Biol. Chem.*, 1919, 33, 371, 372. The non protein nitrogen determined by the Kjeldahl method. *J. Biol. Chem.*, 1919, 33, 371, 372.
- GAMBLE, J. I. and McIVER, M. A. A study of the effects of pyloric obstruction in rabbits. *J. Clin. Invest.*, 1935, 1, 531.
- HOWE, P. E. Determination of blood proteins. In Hawk and Bengtson. *Practical Physiological Chemistry*, 10th Edition, p. 398. Philadelphia: P. Blakiston's Son & Co.
- LEW, R. K. S., IVY, A. C., and MCCARTHY, J. E. Contributions to the physiology of gastric secretion. *Quart. J. Exper. Physiol.*, 1915, 10, 13.
- VAN SICKLE, D. D. The determination of chlorides in blood and tissues. *J. Biol. Chem.*, 1923, 17, 523.
- WANGENSTEEN, O. H. Nasal tube suction siphonage. *Arch. Surg.*, 1933, 22, 933.

## II THE DETERMINATION OF THE WEIGHT AND AGE OF THE FETUS IN UTERO BY THE AID OF STEREOROENTGENOMETRY<sup>1</sup>

STEWART H. CLIFFORD M.D. Boston

IN the first study of this series a method of X ray measurement was described that gives reliable information as to the occipitofrontal diameter of the fetal head *in utero*. It is the scope of the present communication to present means whereby this occipitofrontal diameter may be translated into the practical terms of fetal age and body weight.

Scammon and Calkins have established "the law of uniform fetal growth ratios" which states that during the fetal period linear growth of the various parts of the body takes place at a uniform rate. In their studies they have calculated the growth of the occipitofrontal diameter (by empirical formula) with respect to age in the fetal period. This relationship is presented in Figure 1 so that from a given occipitofrontal diameter the age of the fetus *in utero* may be stated in lunar months.

While this information is of considerable interest it helps but little in enabling the obstetrician to visualize accurately the size of the fetus *in utero*. An attempt has been made therefore, to translate the significance of the occipitofrontal diameter into the comprehensible terms of body weight. The relation existing between the occipitofrontal diameter and birth weight has been investigated in 479 newborn infants and is expressed in the accompanying graph (Fig. 1). Curves have been constructed by inspection for the estimation of the minimum, average, and maximum body weight to be expected for any given occipitofrontal diameter. Table I has been compiled from this data and gives the same information.

Knowledge as to the size of the fetus *in utero* has proved to be of particular value in cases complicated by toxæmia, heart disease, bleeding, or any other condition that might necessitate an early termination of pregnancy. Brief summaries of a few case histories are presented at this point that illustrate the ap-

plication of this service to specific obstetrical problems.

**CASE 1.** A 27 year old primipara was examined in the eighth month and immediately sent into the hospital because of vaginal bleeding. She had had painless bleeding for the preceding 2 days and had passed about a quart of blood. On admission she was in good condition and was not bleeding.

Stereoroentgenometric examination found the fetal occipitofrontal diameter to be 11.5 centimeters. This indicated a minimum fetal weight of 5 pounds (2,267 grams) and a probable weight of 6 pounds 12 ounces (3,075 grams).

Three days after admission vaginal examination established the diagnosis of placenta previa and started some fresh bleeding. A cesarean section was performed immediately under gas oxygen and ether anesthesia with the delivery of a 5 pound 12 ounce (2,625 gram) infant whose actual occipitofrontal diameter was 11.6 centimeters. Both mother and infant were discharged later in good condition.

**CASE 2.** This patient had lost her first child and her second pregnancy resulted in a miscarriage at 2 months. She developed toxæmia and chronic nephritis during her third pregnancy and although she went to full term a small macerated fetus was precipitated. From the third month of her fourth pregnancy she showed a slight trace of albumin in the urine but the blood pressure stayed within normal limits until later. The question of a therapeutic abortion was considered but as the patient was extremely anxious to have a child pregnancy was allowed to continue.

An X ray determination of fetal size was made in the seventh month and the fetal occipitofrontal diameter found to be 9.9 centimeters. This indicated a minimum fetal weight of 3 pounds (1,360 grams) and a probable weight of 3 pounds 8 ounces (1,600 grams).

Because of the small size of the fetus and because the maternal condition permitted, pregnancy was allowed to continue for another month. By that time the blood pressure was found to have risen to 134/90 and a large trace of albumin had appeared in the urine. The X ray examination was repeated and the occipitofrontal diameter now found to be 11 centimeters which meant a minimum fetal weight of 5 pounds (2,267 grams) and a probable weight of 6 pounds 12 ounces (3,075 grams).

Labor was induced and the patient delivered a 6 pound 2 ounce (2,778 gram) infant with an actual occipitofrontal diameter of 11.1 centimeters.

<sup>1</sup> I am indebted to Dr. Paul Overstaen for permission to report this case.

<sup>2</sup> Studies on the Reduction of the Newborn Infant Death Rate from the Boston Lying in Hospital, the Departments of Obstetrics and Pediatrics of the Harvard Medical School and the Department of Child Hygiene of the Harvard School of Public Health. Part of a communication originally read before the Boston Obstetrical Society on October 18, 1931.

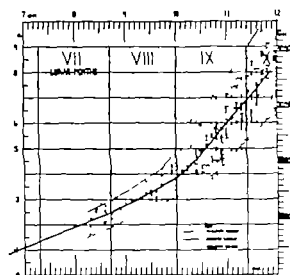


Fig. 1. The relation between the occipitofrontal diameter and birth weight as observed in 479 newborn infants. The relation between the occipitofrontal diameter and fetal age is derived from the studies of Scammon and Callina.

Pathological examination of the placenta showed a partial premature separation and an edematous umbilical cord. Microscopically the placenta presented the picture associated with chronic nephritis, hemorrhage into the decidua and fetal arteritis.

**CASE 3.** A 26 year old *ii-para* had been delivered previously by cesarean section because of a compound presentation and a question of disproportion. She was found to have rheumatic heart disease with mitral stenosis and paroxysmal auricular flutter. In the eighth month of her pregnancy she was discovered to be fibrillating. She was examined by X-ray and the fetal occipitofrontal diameter demonstrated to be 11.3 centimeters. This indicated a minimum fetal body weight of 5 pounds (2,267 grams) and a probable weight of 6 pounds 13 ounces (3,075 grams). Delivery was accomplished by cesarean section under drop ether anesthesia. The infant actually weighed 6 pounds 10 ounces (3,000 grams) and had an occipitofrontal diameter of 11.3 centimeters.

**CASE 4.** A 25 year old *primipara* was admitted to the hospital in the seventh month of pregnancy with the diagnosis of chorea. The cardiologist advised delivery as soon as the baby was believed to be viable. By X-ray examination the fetal occipitofrontal diameter was found to be 10.6 centimeters. This indicated a minimum fetal weight of 4 pounds (1,814 grams) and a probable weight of 5 pounds 8 ounces (2,500 grams). The patient was delivered from below of a 5 pound 12 ounce (2,600 gram) infant whose actual occipitofrontal diameter was 10.9 centimeters.

Certain interesting figures have been obtained concerning the rate of increase of fetal

body weight that are in accord with existing clinical impressions. In the seventh and eighth lunar months the fetus slowly increases in weight at the rate of 5 and 6 ounces per week respectively. During this period the total body weight of the fetus increases from a little over 1 pound (600 grams) to 4 pounds (1,800 grams).

In the last 2 lunar months of pregnancy the fetus begins to increase in weight at a much more rapid rate while at the same time maintaining the previous rate of skeletal growth. This increase in weight is due to the laying down of large deposits of subcutaneous fat and water and increase in muscular development. The rate of increase in weight jumps to between 8 and 12 ounces per week. Appreciation of this rate of weight gain is of great obstetrical importance for it means that even a 2 weeks' delay in the induction of labor will result in an increase in fetal weight of from 1 to 1½ pounds. In this connection it may be of interest to point out that where as in our experience the mortality rate for infants of less than 5 pounds has been between 48 and 29 per cent, the mortality for infants of from 5 to 6 pounds has been less than 3 per cent.

Fortunately in the group of infants of greatest interest from the point of view of their degree of maturity a close relationship was found to exist between body weight and occipitofrontal diameter. In infants of a body weight less than 4 pounds (1,800 grams) it was possible to predict their actual weight from an estimated occipitofrontal diameter with reasonable accuracy. In the series investigated, all infants with an occipitofrontal diameter of less than 10 centimeters were found to weigh less than 4 pounds (1,800 grams). Those with a diameter between 8 and 9 centimeters were found to weigh less than 3 pounds (1,360 grams). Those whose diameters were below 8 centimeters were all non viable.

There were such wide variations of possible weights encountered above and below the mean expected body weight curve in the last 2 months of pregnancy that it was impossible to give an accurate prediction of the birth weight to be expected in the individual case. It was possible, however to predict the

minimum weight that might be encountered for any given occipitofrontal diameter and at the same time give the average or probable weight to be expected. In these latter months to be assured of the minimum weight that might be encountered in an individual case is of great practical importance in enabling the obstetrician to choose the safest course of action. In the group investigated an occipitofrontal diameter of 10.5 centimeters assured the obstetrician of an infant weighing at least 4 pounds (1,800 grams) while a diameter greater than 11 centimeters indicated a body weight of at least 5 pounds (2,267 grams).

The occipitofrontal diameter may be assumed to increase *in utero* at the rate of from 10 to 12 millimeters per month. Thoms has found that in heads with an occipitofrontal diameter up to 11 centimeters the biparietal diameter may be obtained by subtracting 1.5 centimeters.

The determination of fetal size has been of considerable value in the handling of cases complicated by any condition—such as toxemia, heart disease, or bleeding—that might necessitate an early termination of pregnancy. It is a great comfort to be assured of the viability of the baby prior to the premature induction of labor or delivery by cesarean section. Many times in the course of our studies when a small fetus has been revealed by X ray examination the maternal condition has permitted a prolongation of the pregnancy, thus greatly increasing the infant's chances of living. On the other hand, it has been found even more frequently that when the examination is made the fetus is already of sufficient size that a further prolongation of pregnancy, with its considerable hazard to both the mother and infant, is unnecessary.

#### CONCLUSIONS

1. A graph has been prepared, based on a study of 479 infants, from which it is possible to estimate the weight and age of the fetus *in utero* from the stereoradiometric determination of the occipitofrontal diameter of the fetus.

TABLE L.—A TABLE FOR THE PREDICTION OF THE MINIMUM AND AVERAGE BODY WEIGHT TO BE EXPECTED FROM A GIVEN OCCIPITOFONTAL DIAMETER

Occipitofrontal diameter in centimeters	Expected body weight			
	English system		Metric system	
	Minimum lbs.—oz.	Average lbs.—oz.	Minimum grams	Average grams
11 2-1 0	6 0	7 12	2777	3233
1 0-11 5	5 0	6 8	2267	2950
0 5-11 0	4 0	5 4	1814	2400
0 0-0 5	3	4 4	1360	1900
9 5 0 0	3	3 8	1360	1600
0 0-0 5	2 8	3 0	1213	1360
8 5 0	2 0	2	907	1150
8 0-8 5	1 8	2	700	1000

2. Data has been presented which suggests that the fetus gains weight *in utero* at the rate of 5 to 6 ounces per week during the seventh and eighth lunar months and at the rate of from 8 to 12 ounces per week during the last 2 months of pregnancy.

3. The determination of fetal size has proved to be of value in the management of cases complicated by toxemia, heart disease, bleeding or any other condition that might necessitate an early termination of pregnancy.

4. Through a knowledge of fetal size many pregnancies that might otherwise be terminated immediately may be prolonged until a viable infant is assured.

5. An X ray examination revealing an infant already of adequate size may make it unnecessary to expose the mother to the hazards of a further continuance of pregnancy and the fetus to the associated danger of intra uterine death.

#### REFERENCES

- CLIFFORD STEWART H. Studies on the reduction of the new-born infant death rate. I. The X ray measurement of fetal head diameter *in utero*. Surg., Gynec. & Obst., 1934, LVIII, 727-736.
- SCAMMON R. E. and CALKINS L. A. Growth in the fetal period. Minneapolis: University of Minnesota Press, 1929.
- THOMS, HENRIK. Fetal cephalometry *in utero*. J. Am. M. Ass. 1930 XCV 21-24.

## THE GRADING OF EPIDERMOID CARCINOMA

OLIVE GATES M.D. AND SHIELDS WARREN M.D. BOSTON

From the Laboratory of Pathology of the Castle P. Huntington Memorial Hospital and the Department of Pathology Harvard Medical School

THE pathological material of the Huntington Memorial Hospital and the Massachusetts State Tumor Diagnosis Service has been unusually rich in epidermoid carcinomata. Since formal histological grading of malignancy was first developed for this group of tumors (1) and even now is most successfully applied to them a study of our material should prove of value.

Since the opening of the hospital in 1912 5,052 separate epidermoid carcinomata have been diagnosed in the laboratory. Many of these had more than one biopsy but the duplicates have been eliminated. There was practically no variation in grade between subsequent biopsies on the same tumor.

These 5,052 cancers were removed from 4,087 patients there being 35 cases of multiple epidermoid cancers. In addition to these 35 cases, there were 24 with one epidermoid cancer and one or more cancers of other types. Five of the multiple cases showed 3 or more distinct lesions. The 5 multiple cancer cases which came to autopsy have been discussed in our previous report (9). Undoubtedly other multiple cases occurred in the series although not known to us as the biopsy material was not sent to this laboratory.

Our system of grading has been described elsewhere (7). In essence it parallels Broders but we use three grades rather than four.

While many tumors are fairly uniform histologically throughout thus making grading fairly easy others vary. We have arbitrarily chosen the least differentiated portion on which to grade never less than one third but make allowance for the presence of a higher degree of differentiation elsewhere in the tumor. We feel that the grade should be determined from the least differentiated portion of the tumor rather than the whole since any practical value of grading rests on the clue it gives to the subsequent behavior of the tumor. This tends to be determined at least in epidermoid carcinoma by the most active portion.

Cellular differentiation is undoubtedly the most important point to be considered. We believe differentiation of the type cell of the epidermoid carcinoma to parallel chiefly the degree of keratinization. However in addition to this point, increase in mitotic activity and particularly the presence of abnormal mitoses, increased variation of cell size and shape, increased tendency to infiltration of the tissues all indicate higher degrees of malignancy. Stromal changes we regard as without significance in determining the grade. Usually marked lymphocytic infiltration occurs in the lower grades of cancers although this is by no means constant. Eosinophilic infiltration is most probably determined by the extent of necrosis of lymphocytes.

We have not endeavored in this study to differentiate between the various types of keratinization. It is not sufficient to lay down one arbitrary pattern for grading. It must be adapted for the tissues of each locality with due regard for the character of the normal epithelium of the part. Thus an epidermoid cancer of a given grade is more heavily keratinized in the lip than the tongue, the vulva than the cervix uteri.

The slides were studied and graded by each of us individually and then checked and compared. Some either because of scanty biopsy material, poor technical treatment or extraordinary variability in histological appearance could not be satisfactorily graded. These made up only 2 per cent of the total.

## HISTORICAL SUMMARY

While grading was originally developed as an aid to the prognosis of individual cases (1) there has been an increasing tendency even among its advocates, to decri too close correlation between the grade of malignancy and the end result in any given case. However its value in establishing group prognosis has yet to be seriously challenged. In certain types of tumors, to be sure its accuracy is distinctly less than in others, and

TABLE I.—RELATIVE FREQUENCY OF GRADES IN VARIOUS SITES

		Grade I		Grade II		Grade III		N	Totals
		No.	Per cent	No.	Per cent	No.	Per cent		
Run, head, and neck	♂ ♀	179 34	65 60	110 44	8 5	30 7	7 6	438 179	607
Skin, covered body surfaces	♂ ♀	37 33	60 58	15 4	38 5	9 7	3 7	54 50	10
Skin, head, and foot	♂ ♀	90 40	85 90	18 4	15 4			95 44	149
Lower lip	♂ ♀	44 12	75 60	123 5		4 2	3 2	577 7	584
Buccal cavity	♂ ♀	438 67	52 52	313 47	37 37	93 3		843 7	850
Respiratory tract	♂ ♀	5 3	46 38	43 0	38 24	8 8	16 28	3 29	142
Esophagus	♂ ♀	18 7	30 33	34 25	53 45	0 4	16 0	6 8	83
Unusual sites	♂ ♀	4 10	25 42	11 9	60 37	5 3	6 3	16 34	40
Genitalia	♂ ♀	38 430	96 37	7 790	34 53	5 300	20 20	50 1580	1630
Urinary tract	♂ ♀	4 8	16 3	4 5	16 5	7 3	68 56	3 8	47
Totals	♂ ♀	1391 790	61 35	60 947	30 45	90 43	8 20	2273 68	4351
		8130	40	1630	37	6	14	4181	

Note: This table does not include cases with data as to site, sex or age missing

in some no satisfactory means of grading has yet been evolved

In the group of the epidermoid carcinomata, however, there has been fairly uniform success attained by those who have made use of the methods of histological grading. Of marked importance, in the group of the epidermoid carcinomata in particular has been the growing tendency emphasized by Ewing, to regard grading as having significance not only from the standpoint of end results, but also from that of immediate treatment. It seems quite clear that the radiosensitivity of a tumor increases as its grade of malignancy increases. One must be careful not to confuse radiosensitivity with what we may term radio-curability. For example, certain of the grade III carcinomata of the cervix uteri melt away with striking rapidity under radium treatment but recur very promptly and kill in a relatively short period of time in spite of treatment. Practically every case of grade III carcinoma of the cervix that we had an opportunity to follow recently has shown an immediate response to radiation with apparent complete or nearly complete disap-

pearance of the local growth followed by prompt recurrence and usually metastasis.

As is natural in the attempt to perfect none too-well functioning systems there have been many modifications of the criteria used in the grading of tumors and various factors have been introduced which may or may not be of importance in determining the grade of malignancy. In our experience, the more complicated methods have not proved of any greater value than the simpler ones. Thus we have graded a small group of tumors reported here by Hueper's system and have not found significant variation from the results obtained by our own less cumbersome method of estimation of malignancy.

While various groups of tumors are still regarded with uncertainty when it comes to assignment of histological degree of malignancy none the less in most of the epidermoid carcinomata it is now generally believed possible to make a fair approximation of the grade (3). In this due consideration must be given the various clinical factors as well as the picture of pathological malignancy before any attempt is made at prognosis bear-

TABLE II.—RELATIVE FREQUENCY OF GRADES BY AGE

		0-9		10-19		20-29		30-39		40-49		50-59		60-69		70-79		80+		No.	Per cent.	Total
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.			
Grade I	♂	7	8	18	13	98	105	13	15	10	12	15	16	15	16	4	9	7	9	990	78	1153
	♀		3	16	7	37	111	180	15	13	15	15	15	15	15	15	15	15	15	111	80	643
Grade II	♂		3	7	3	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
	♀		3	7	3	11	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Grade III	♂	7	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	111	78	100
	♀		4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	111	78	100

TABLE III.—CANCER OF THE CERVIX UTERI BY AGE AND GRADE

Grade	Total	20-29		30-39		40-49		50-59		60-69		70-79		80+	
		No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.	No.	Per cent.
I	33	3	4	11	5	103	79	14	33	15	15	3	4		3
II	741			86	14	26	33	134	23	108	1	14	3		3
III	150	14	4	19	13	97	66	93	63	15	17				

ing in mind that the grading will of necessity be always uncertain so far as individual application goes, even though it may be of very definite value from the standpoint of group prognosis and still more so from the standpoint of determining relative susceptibility to radiation of the various cancers which may be encountered in a given site.

#### THE RELATIVE FREQUENCY OF GRADES IN VARIOUS SITES

Through our attempts to correlate the criteria used in histological grading with the picture normally presented by the epithelium in each part we feel that Table I offers fairly comparable data. In it we have endeavored to present the relative frequency of the various grades of malignancy for a given site as encountered in our material.

Thus it will be seen that in epidermoid cancers of the external surface of the head and neck grade I tumors outnumber grade III ten to one. This closely parallels clinical experience with these tumors the bulk of which do well under treatment rarely metastasize, and even then are practically restricted to the regional nodes. Moreover relatively large doses of radiation are required to effect disappearance of these tumors, the low grade paralleling radioresistance. In the hand and foot no grade III cancers were encountered

among 149, and only 13 per cent belong in grade II again in keeping with their low clinical malignancy.

In the lower lip (including unspecified lip cases practically all of which are probably lower) the relatively benign character of the lesions is even more striking. This further emphasizes the fact that most failures in the treatment of lip cases are caused either by initial delay or inadequate treatment.

The buccal cavity presents a strikingly different picture. Here only half the cases fall in grade I although a lesser degree of keratinization was exacted for this grading than in the external cancers. In the respiratory tract a similar ratio prevails.

The cervix uteri presents an even more marked reversal of these relationships, grade III being as frequent as grade I, and grade I making up only one fourth of the total. This again would be expected in view of the clinical behavior of cervical cancer and the frequency of generalized metastases, which are far more common in this than in the other groups mentioned (8). True it may be objected that the facial and lip cancers have a more clearcut lymphatic barrier to hurdle before reaching the viscera, but none the less this is by no means impenetrable, as the melanomata of the face and scalp prove only too well.

TABLE IV—DISTRIBUTION OF EPIDERMOID CARCINOMATA BY GRADE, SITE, AND SEX

		Grade I		Grade II		Grade III		Totals		
		No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent	
Skin, head, and neck	♂ ♀	179 174	50 31	19 44	73 27	30 1	73 27	408 175	71 29	603
Skin, covered body surfaces	♂ ♀	37 33	83 47	5 14	51 48	2 9	18 82	54 30	40 51	118
Skin, hand, and foot	♂ ♀	90 40	69 51	15 4	79 21			105 44	70 30	149
Lower lip	♂ ♀	445 13	97 3	122 5	96 4	14 00	00	577 17	97 3	594
Nasal cavity	♂ ♀	418 67	87 13	112 47	87 13	23 3	88	843 27	87 13	970
Respiratory tract	♂ ♀	51 11	83 17	43	81 19	8 3	60 3	113 20	80 30	143
Esophagus	♂ ♀	18 7	73 28	34	77 3	4	7 19	61 2	73 23	83
Uterus and sites	♂ ♀	4 10	20 71	11 9	35 41	5 3	17 83	6 24	40 60	40
Genitals	♂ ♀	18 439	6 94	7 799	03 03	5 360	1 99	30 1360	3 97	1630
Urinary tract	♂ ♀	4 5	44 50	4 3	44 50	17 1	50 4	25 5	53 47	47

A uniform division of the number of cases in a given grade is not essential, and indeed should not be expected. We believe that the lower grades of malignancy predominate in some sites, and the higher grades in others, and that this variation may explain in part the varied clinical behavior of cancer in different localities.

#### AGE AND GRADE

There is a widespread and well founded impression that cancer in young people is a much more virulent disease than in the elderly. Whether this rests on properties of the growths themselves or of the host is not clear, and a comparison of relative frequency of the grades of malignancy at different ages is definitely indicated. Should grade III cancers predominate in the young the question would be at least partly answered.

However study of our material disappoints us. Regardless of the location of the tumor, the relative frequency of the grades remains the same in each age group. Thus males under 40 years of age had 4.4 per cent of the grade I cancers of the skin of the face and head, 7 per cent of the grade II and 3 per cent of the grade III. Similarly in cancer of the mouth males under 40 years of age had

1.7 per cent of the grade I cancers, 2 per cent of the grade II and 3 per cent of the grade III. Males 80 years of age or over presented 10 per cent of the grade I face cancers, 12 per cent of the grade II, and 3 per cent of the grade III group. The same insignificant variations are shown in cancers of other sites.

Combining several of the important sites in Table II (skin of the face and head, trunk, hands, and feet, and other scattered sites) a surprising similarity of frequency in the various age groups is shown in all three grades, whether the sexes are considered separately or together. Curiously enough the sex distribution also is almost identical in the three grades: 76 per cent of the grade I cancers, 80 per cent of the grade II, and 76 per cent of the grade III occurring in males.

Cancers of the cervix uteri occur at a younger age than tumors elsewhere (49 per cent in patients below 50 years of age, against 14.8 per cent for the group in Table II). However, the age distribution runs closely parallel for all three grades. This point is well brought out by Table III.

#### SEX DIFFERENCES

One interesting point brought out in the course of this study is the relative sex dis-



TABLE V.—RELATION OF MULTIPLE CANCERS TO GRADE

	Grade I		Grade II		Grade III		Ungraded	
	No.	Per cent	No.	Per cent	No.	Per cent	No.	Per cent
Multiple cases	15	54	39	28	6	6		
All cases	2130	43	1240	27	6	4		

tribution of epidermoid carcinomata in various sites. In Table IV we note a marked preponderance of head and neck cancers (excluding lower lip) in the male (70 per cent as against 30 per cent). This is particularly marked in the case of the ear (88 per cent as against 12 per cent). The exposure of the male ear as contrasted with the female is undoubtedly an important factor. Not a few cases of carcinoma of the ear in the male give a history of antecedent frost bite.

The skin of the upper face and the nose where exposure is not unlike in the two sexes shows a less preponderance of cancer in the male (58 per cent as against 42 per cent).

In the covered regions of the body epidermoid cancer of the skin runs closely parallel in the two sexes (49 per cent in males and 51 per cent in females). In the extremities 70 per cent of the cases occurred in males.

Cancer of the lower lip is above all others essentially a male lesion 29 per cent only occurring in females. The buccal cavity also presents a striking male preponderance (87 per cent). This preponderance is consistent in all parts of the buccal cavity.

When we consider the genitalia however the bulk of the cases occur in females, due to the great number of cases of cancer of the cervix uteri. Here 97 per cent the proportion of female cases, is as striking as the marked predominance among males of the lip cases.

In spite of these wide variations in different parts of the body the balance of the two sexes is very close in the entire group 52 per cent being male and 48 per cent female.

The higher malignancy of the cancers of the cervix does cause a greater percentage of epidermoid cancers in the female to fall in the higher grades. Whereas of all our graded epidermoid cancers in males 61 per cent fell in grade I and only 9 per cent in grade III

in females only 36 per cent were classified as grade I and 20 per cent as grade III.

In most sites, however the sex ratio remains constant regardless of the grade. When marked variation appears the number of cancers is small and the statistical significance but slight.

#### RELATION OF GRADE TO METASTASIS AND TO MULTIPLE CANCERS

One point that has interested us has been as to whether a given cancer maintained its grade in its metastases or became more or less malignant. This data has been obtained in only a relatively few cases because often only the primary growth was sent to the Tumor Diagnosis Service and because of the frequent failure of grade I cancers (of which the series contains many) to metastasize. From the data available we feel that usually the grade is maintained in the metastasis. If a change is noted the metastasis is as frequently of a lower grade than the primary as of a higher. This impression parallels the experience of Mills, Broders, and Caylor.

The relative likelihood of metastasis in the different grades is beyond the scope of the present study but has been presented in detail by us for certain groups of cancers (8) and further studies are in progress.

In our cases of multiple malignancy the grades of the epidermoid carcinomata do not vary significantly from the distribution by grades in our entire series. While we have pointed out (9) that cases of multiple cancer are more frequent than would be expected on the basis of chance we see no reason to assume as corollary to this, as Hurt and Broders do that 'the average grade of malignancy of multiple primary tumors should be higher than in a like group of single malignant tumors. In fact one of the most frequently occurring cancers in multiple cases is

the basal cell carcinoma which is certainly of as low malignancy as any type. As may be seen from Table V, grade I tumors predominate in our group of multiple cases.<sup>1</sup>

#### SUMMARY

1 The frequency of various grades of malignancy has been studied among 5,052 epidermoid carcinomata, removed from 4,987 patients.

2 Three grades of histological malignancy have been determined, chiefly on the basis of the degree of differentiation of the neoplastic cells.

3 Histological grading should not be used as a guide in individual prognosis, but is of service in determining group prognosis and of much help in estimating the probable radio-sensitivity of a given cancer.

4 In general, epidermoid cancers developing in sites where the clinical malignancy is low tend to be of low histological malignancy.

<sup>1</sup> By the nature of this study, multiple cases other than those having at least one epidermoid carcinoma are excluded.

and where the clinical malignancy is high, the number of cancers in the higher histological grades of malignancy is increased.

5 Histological malignancy is independent of age and sex.

6 In certain sites epidermoid carcinoma is practically a sex limited disease.

7 Metastases tend to be of the same grade as the primary tumor from which they arose.

8 The histological malignancy is no greater in cancers from cases of multiple malignancy than in single cancers.

#### REFERENCES

- 1 BRODERS, A. C. *J. Am. M. Ass.* 1920 lxxiv 650
- 2 LEWIS, J. *Radiology* 1930 xiv 186
- 3 HELLWIG, C. A. *Arch. Path.* 1932 xiv 517
- 4 HUEPPEL, W. C. *Arch. Path.* 1928 vi, 1064.
- 5 HURT, H. H. and BRODERS, A. C. *J. Lab. & Clin. Med.* 1933 xviii, 765
- 6 MILLS, R. C. BRODERS, A. C. and CAYLOR, H. D. *Surg. Gynec. & Obst.* 1931 lxi 824.
- 7 WARREN, S. *Arch. Path.* 1931 xii, 783
- 8 Idem. *Surg. Gynec. & Obst.* 1933, lvi 742
- 9 WARREN, S. and GATES, O. *Am. J. Cancer* 1932 xvi 1358

AN EARLY HUMAN EMBRYO *IN SITU*

ROBERT TENNANT M.D. AND ELIZABETH M. RAMSEY M.D. NEW HAVEN, CONNECTICUT  
 From the Department of Pathology Yale University School of Medicine

THE specimen which forms the subject of this report was discovered in the course of a postmortem examination which was made upon the body of a young woman who died in the New Haven Hospital on July 5 1932.

Thirteen hours before her death she had taken two teaspoonfuls of an arsenic containing insecticide. Vomiting, diarrhea, and abdominal pain commenced within a short time after ingestion of the poison. The patient was in a state of shock when she was admitted to the hospital. Despite the administration of arsenic antidotes and general supportive measures she succumbed. No information pertaining to the menstrual history could be obtained. The necropsy was performed 5½ hours after death and in the intervening time the body was kept at 6 degrees centigrade. The primary anatomical changes included acute hemorrhagic and ulcerative gastritis and enteritis, epithelial and lymphoid proliferation and focal abscesses of the thyroid, diffuse myocarditis, subendocardial hemorrhage (right ventricle).

The examination of the genital tract was made with great care as the initial inspection of the uterus revealed it to be boggy and enlarged and the possibility of an early pregnancy was recognized. In detail the gross findings in the genital tract were as follows: The mucosa of the vagina was pale pink, intact, and corrugated. The cervix was soft, symmetrical and somewhat enlarged. Projecting from the os was a white mucoid plug which completely filled the opening. The uterus was soft and symmetrically enlarged. The external overall measurements were 18 by 6.5 by 5 centimeters. On section the cavity was found to contain a small amount of mucoid material which clung tenaciously to the endometrium, particularly in the region of the fundus and right cornu. The endometrium was smooth, intact and bright pink. In the fundus and right horn numerous minute engorged blood vessels beneath the intact endometrium imparted a deep red appearance to the surface. Situated on the lateral wall halfway between the fundus and the internal orifice was a similarly reddened zone in the center of which was a tiny pale yellow elevation 3 millimeters in diameter. The cross section of the uterine wall was not thickened and the cut surface presented a homogeneous, pale red appearance. The fallopian tubes were pale pink, soft and patent, their walls were not thickened and the fimbriated ends were free. The ovaries together weighed 9.4 grams. In the right ovary was a corpus luteum 2 centimeters in diameter.

## MATERIAL

Blocks of tissue for microscopic study were removed from the right fundic region of the uterus from the left lateral uterine wall including the pale yellow elevation and from the right ovary. The blocks were immediately fixed in Zenker-acetic solution for 24 hours. They were washed in tap water for an equal length of time and then dehydrated in graded alcohols and prepared for paraffin embedding. A section was cut from each block and stained with hematoxylin-eosin. In the case of the uterine tissues the plane of section was vertical to the endometrial surface. The section from the left lateral wall was found to contain an early ovum superficially embedded in the endometrium. The remainder of this block was accordingly cut in serial, each section was 104 thick and all were mounted and stained with hematoxylin-eosin.

The series of 225 sections contains the entire blastocyst with the exception of a small portion of one end which was cut away when the block was trimmed. From a detailed study of the whole blastocyst it is estimated that not more than 50 sections are missing from this portion, i.e. 25 sections to the end of the cavity of the blastocyst and 25 sections containing chorionic villi.

## GENERAL DESCRIPTION AND DIMENSIONS OF OVUM

Microscopic examination shows the ovum to be situated in a small prominence of the endometrium. Only in a small area toward the uterine cavity does the endometrial tissue fail to enclose the ovum. Here the defect is filled with an admixture of fibrin and blood cells undergoing early organization. The cavity of the blastocyst is lined with several layers of loosely arranged mesenchyme and filled with a mass of finely granular pink staining material. The embryo is attached to the mesenchyme on the inner wall of the chorion opposite the uterine cavity and extends from section 48 to section 88 inclusive. It consists

of embryonic plate, amnion and yolk sac, and is surrounded by mesothelium

Measurements of the several parts of the ovum were made from the projected images at known magnifications and from the number of serial sections in which the parts are contained. All measurements were taken at regions of maximum diameter. The external measurements of the blastocyst are 2.75 by 1.92 by 0.92 millimeters. The internal dimensions of the blastocyst are 2.17 by 1.40 by 0.61 millimeters. (Allowance was made in computing the long diameters of the blastocyst for the amount believed to have been lost in trimming of the block.) The external measurements of the embryonic mass are 0.41 by 0.24 by 0.17 millimeters. The ectodermal disc measures 0.24 by 0.3 millimeters. Its thickness was not computed.

#### ENDOMETRIUM

The surface epithelium of the endometrium in general is intact. The endometrial glands are greatly enlarged and have the typical corkscrew appearance of the premenstrual mucosa. The cells lining the glands are tall columnar with pink granular cytoplasm and pale blue vesicular nuclei. No mitotic figures are seen. The cells are swollen and project irregularly into the lumen of the glands. In many places the epithelial cells have desquamated and lie free within the lumina together with a finely granular pink staining maternal. Throughout the endometrium the stroma is oedematous, the capillaries are distended with blood and there is a sparse scattering of polymorphonuclear leucocytes.

The implantation site is sharply demarcated from the rest of the endometrium by a zone of widely dilated capillaries which form a cushion upon which the blastocyst rests. In this border zone there appears to be more oedema and cellular infiltration than elsewhere in the endometrium. In several places, particularly near the surface, there is also extravasation of red blood cells.

#### TROPHOBLAST

The wall of the blastocyst is irregular in outline with numerous small outpouchings in to which the mesothelium extends. An average of 8 to 10 such projections are seen in each

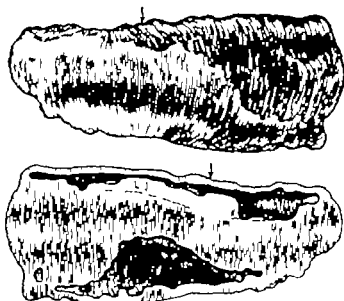


Fig. 1. Upper: Lateral view of embryo drawn from wax reconstruction,  $\times 16\times$ . The darker zone represents the attachment to the primary mesenchyme; the light zone, the surface exposed to the chorionic cavity.

Lower: Median sagittal section drawn from model,  $\times 16\times$ . The dorsal cavity is the amnion and the ventral the yolk sac. The arrows indicate the location of section for photomicrographs of which are presented in Figures 2 and 3.

section. These apparently represent primitive chorionic villi and in approximately one half of the instances a dichotomous division has occurred.

Immediately outside the mesothelial lining of the chorionic cavity is a single layer of small cuboidal cells arranged in palisade. Occasionally the cells are heaped up into 2 or 3 irregular layers, particularly in the outpouchings. The cytoplasm of the cells is deep pink and granular and the individual cell outlines are distinct. The nuclei, which are vesicular and contain dark blue granular chromatin, occupy the greater part of each cell.

Closely adherent to the outside of the cuboidal cell (Langhans) layer is a thin lavender staining protoplasmic covering (syncytium). Cell outlines here are absent and dark blue irregularly elongated nuclei are distributed at intervals. Protoplasmic prolongations of this layer extend outward and form the lining of large spaces which are filled with blood. In many instances these lacunae are immediately adjacent to the wall of the blastocyst; elsewhere they are further back from the cavity, but in all cases the syncytium lines the space. Other syncytial processes ex-



Fig. 2 A photomicrograph of the implantation site which shows the relation of the ovum to the surrounding endometrium and uterine cavity. The embryonic mass, the chorion, the trophoblastic layers and the dilated blood vessels of the border zone show clearly.  $\times 50$

tend into the surrounding endometrial stroma and appear to invade the walls of the dilated blood vessels. In many places direct communication between the lacunae and the capillaries has been established.

Between the lacunae extending radially from the cuboidal cell layer are masses of large foamy polyhedral cells with large pale blue vesicular nuclei. The cell boundaries stain pink and stand out prominently. Mitotic figures are abundant. These columns extend outward and gradually merge into the surrounding endometrial stroma within the zone of the dilated capillaries.

#### EMBRYO

In Figure 2 is seen a low power photomicrograph of the entire ovum (Section 61). The embryo proper is attached to the mesenchyme on the inner wall and at one pole of the chorionic cavity. Its general form is indicated by the drawings of a wax reconstruction of the entire embryo presented in Figure 1. In the external view the shaded portions show the places of attachment to the primary mesenchyme while the light areas represent the surfaces which are exposed to the cavity of the chorion. It is of interest to note that the left end stops bluntly and is entirely free of mesothelial attachment while the right is completely encased in mesenchyme. The dorsal surface forms the greatest area of at-



Fig. 3 A photomicrograph of the embryonic mass seen in Figure 2. Amnion, chorion, and ectodermal plate are seen lying at one pole of the blastocyst attached to the chorionic mesenchyme and surrounded by an endothelium-like mesothelial membrane.  $\times 215$

tachment. The ventral surface is almost entirely free with the exception of a small band of attachment extending about halfway along this surface from the encapsulated end. The median sagittal section shows two cavities, the dorsal represents the amnion and is the larger of the two. The floor of the amnion has an extremely irregular outline which is the result of the marked shrinkage and displacement of the cells of the ectodermal plate. The broken line represents the level at which the floor of the amnion presumably would be situated were the cells undisturbed in their alignment. The ventral cavity is the yolk sac which is completely separated from the amnion by the intervening ectodermal plate. At the left end is a duct like projection of the cavity which extends into the enveloping mesenchyme.

Figure 3 is a high power photomicrograph of Section 61. It shows the embryo and the immediately surrounding portions of the blastocyst. The yolk sac is lined by endodermal cells which are cuboidal on the dorsal surface and flattened on the ventral surface. The sac is partially filled by pink staining finely granular material. In other sections large yolk granules are present within the cavity. The endodermal lining of the yolk sac abuts on the basement membrane of the ectodermal plate with no vestiges of an intervening mesothelial layer. The embryonic shield forms the

floor of the amnion and is made up of a single layer of tall columnar cells arranged in palisade resting on a distinct basement membrane. The cells have large, oval vesicular nuclei and abundant cytoplasm. In the middle of the ectodermal plate their outlines are indistinct and the regularity of their arrangement is destroyed. The lateral walls and roof of the amnion are lined with flattened, elongated cells. The roof is bound intimately to the overlying mesenchyme.

Around the embryonic mass is a space which in many places is continuous with the chorionic cavity although for the most part it appears to be closed off from the main chamber. This space is limited by a single layer of flattened mesodermal cells having the appearance of endothelium. This layer not only surrounds the space but likewise completely encloses those surfaces of the embryonic mass not directly attached to the mesenchyme. On the surface toward the main cavity the continuity of this membrane like structure is less well maintained, and irregularly distributed openings in it offer probable avenues of communication between the larger and smaller spaces. In addition from this surface long strands of mesenchymal cells stretch out traversing the main cavity. A finely granular, pink staining material similar to that in the main cavity of the blastocyst is present within the smaller space.

#### SUMMARY

The state of preservation of the structures of the specimen is excellent. Only in certain details are there evidences of early disintegration, in summary

The epithelial cells of occasional endometrial glands have sloughed into the lumina.

The individual chromosomes of the karyokinetic figures are indistinctly differentiated.

The cells of the ectodermal plate have become dislodged from their basement membrane. It is only in this structure that serious distortion of the configuration has occurred.

Since these changes involve only the more fragile structures it seems justifiable to assume that they are of postmortem origin and that the embryo was developing normally until the death of the patient.

In the absence of all menstrual history the age of the embryo must be estimated from a comparison of its developmental stage with that of other young human ova of better known age. The lack of a primitive streak places it in Group I of Streeter's classification. The primitive nature of the chorionic villi, the size of the blastocyst, the relative sizes of the amnion and yolk sac and the dimensions of the embryonic parts indicate that it is of approximately the same age as the Peters embryo, i.e. 12 to 14 days.

The authors wish to thank Professor Leon S. Stone of the Department of Anatomy, Yale University for his guidance and direction in the study of the material presented in this paper. They also acknowledge to Dr. George L. Streeter of the Carnegie Institute their appreciation of the valuable suggestions offered regarding the interpretation of the microscopic preparations.

#### REFERENCES

1. PETERS, H. Ueber die Einbettung des menschlichen Eies. Vienna: Deuticke 1899.
2. STREETER, G. L. A human embryo (Mateer) of the preovulate period. Carnegie Contrib. to Embryology 1930 ix, No. 43, 417.

## CONGENITAL TORTICOLLIS

## A REVIEW AND RESULT STUDY

GARRY DEAN HOUGH, JR. B.S., M.D. F.A.C.S. SPRINGFIELD, MASSACHUSETTS  
*From the Shriners' Hospital for Crippled Children*

**C**ONGENITAL torticollis collum distortum caput obstipum or wry neck, is a well recognized deformity of the head and neck characterized by the approximation of the mastoid process of the temporal bone to the sterno-clavicular articulation on one side or the other. In rare cases the condition may be bilateral with resultant forward inclination of the cervical spine and head.

## HISTORICAL

The condition was recognized in antiquity and Alexander the Great is said to have suffered from the deformity (Colonna). According to von Luckum the first known attempt at correction by open section of the muscle was made by Isaac Minnius in Germany in 1641. In this country the first reported cases were by John Warren of Boston in 1841 and John Brown of the same city in the following year.

Buckminster Brown discussed the treatment and presented cases before the annual meeting of the Massachusetts Medical Society on June 3, 1868. He stated that apparatus particularly the brace devised by Dr. John R. Brown completely relieved many patients, while others are generally incurable without division of the offending muscles.

## INCIDENCE

Tubby observed the incidence as about 0.3 per cent of children in a surgical hospital (8 cases of 2,324 admissions at Evelina Hospital for Children) 0.3 per cent of orthopedic cases (15 of 5,079 cases at the Royal National Orthopedic Hospital) and less than 0.2 per cent of other observed patients (9 of 5,190).

Colonna, reporting from the Hospital for the Ruptured and Crippled, New York, gives the incidence as 0.5 per cent (269 of 55,000 orthopedic cases) while Howell states that it occurs once in every 150,000 births, and is one tenth as common as congenital club-foot.

In the Shriners Hospital for Crippled Children at Springfield Massachusetts there have been 39 cases in 1,898 admissions from the opening of the hospital in February 1925 to September 30, 1933, an incidence of 2.1 per cent. The distribution by years has progressively increased from 0.4 per cent in 1925 to 3.5 per cent in 1932 and 1933.

## TYPE OF DEFORMITY

There are three general divisions of torticollis congenital, acquired and spasmodic. The cases which we are considering in this series are exclusively of the congenital type and we will limit our discussion to this group. In our experience this type has been much more common than the acquired or spasmodic. This is partially borne out by inference from Steindler's report of 27 myotomies of the sternomastoid of which 21 or 80 per cent were for congenital torticollis. Whitman however reports that of 507 cases only 87 or 17 per cent, were congenital while Redard found 18 congenital cases in a series of 70 or 25 per cent. During the past 5 years there has been much more in the literature concerning the acquired than the congenital type.

## SEX DISTRIBUTION

Albee and Howell state that the condition is more common in girls than in boys, and Kempf reports 24 girls and 13 boys in his cases. Whitman's series of 87 is almost equally divided with 46 girls and 41 boys. Colonna found 147 boys and 122 girls. Aberle reported 23 boys and 14 girls. In this series there were 27 boys and 30 girls. Combining the above series we find a total of 251 boys and 236 girls. It appears safe to state that there is no sexual predisposition.

## RACIAL TENDENCY

Racial predisposition is not mentioned in the literature and the condition has been a

subject of interest to writers in French, German, Scandinavian, Italian, Spanish, and English implying widespread occurrence. In our series taken from the mixed racial population of New England, there were 25 Anglo-American, 14 French-Canadian, 8 Italian, 3 German 3 Irish, and 1 each of Swedish, Greek, Armenian and Polish ancestry

#### SIDE INVOLVED

As has been previously mentioned there have been bilateral cases occasionally reported, but these are rare. In the case reported by Gupta, there is insufficient data to classify the condition accurately, but it is obviously not a congenital torticollis. There are no bilateral cases in this series.

Oster states that the right side is affected almost exclusively. Colonna found 27 cases of right involvement and 24 of left in 51 cases while Hutter cites 26 of the right side and 17 of the left in 43 cases, and quotes Grimm's series of 38 cases with 21 right and 17 left as well as Binder's collected statistics showing 344 right and 266 left. Hutter attempts to explain a right sided predilection by the increased venous pressure on the right, due to the valveless veins of the right lobe of the thyroid presenting a straighter continuation of the superior vena cava than do those of the left. He quotes Breitner and Starlinger's observation that diffuse forms of struma are preponderantly right sided. Hutter also states that cerebral abscesses are more frequently right sided than left, and that a survey of hemangiomas of the face showed 14 on the right side to 7 on left. Whitman, on the contrary, reports 20 cases with right sided involvement and 38 left sided in a series of 58 cases. In our series, 31 cases (54 per cent) were right and 26 cases (46 per cent) were left. Combining the above figures we find 469 right sided opposed to 388 left, or 55 per cent right and 45 per cent left. There seems to be a slight predilection for the right.

#### ETIOLOGY

In spite of many theoretical speculations and some careful investigations, there is still a wide variation in suggested causes of this condition. We exclude at once those cases caused

by congenital bony abnormalities, such as hemivertebra cervical rib fusion of the atlas and occiput, or of the axis and atlas. These conditions may simulate true torticollis but in our opinion should be classified as congenital malformation of the cervical spine, and the term torticollis reserved for the deformity of muscular origin. No cases of this type have been included in this series. Albee, Whitman, and Nové-Josseland and Vianny all describe this group under torticollis and Schulze considers this the most frequent cause. All cases in this series have been examined with the X ray and in only one case has a bone lesion or defect been present. This was a mild spina bifida which was felt to be of no significance. Jones and Lovett use the term "primary" for this group of cases, but we much prefer Elowson's nomenclature of "osseous" as opposed to "myogenic" torticollis.

The most widely supported theory of causation is abnormal intra uterine position or increased intra uterine pressure. This is of course entirely speculative but has been a popular explanation, not only of this particular deformity but also of others.

Jones and Lovett use as supporting evidence the co-existence of congenital club-foot due to the same cause. Here again the pressure is subject to question and even if admitted the association does not necessarily follow. No such association of club-foot or other deformity has been observed in this series. Beck denies that uterine pressure can be a cause and cites Sippel's X ray studies as showing intra uterine muscular torticollis without narrowing of the uterus. Campbell lends the support of his statement to abnormal position *in utero* as a cause, as also Whitman, Colonna and Hohmann. Argument against this may be drawn from Joachimsthal and Volcher, who report a case occurring in extra uterine gestation.

Among other theories of etiology are (1) heredity (2) constitutional defect, (3) arrested development (4) birth injury, (5) infective myositis and (6) ischaemic fibrosis.

Aberle and Schubert emphasize the hereditary influence and cite cases to bear out this contention and von Lackum reports three of four children in one family with torticollis.



The number of such reported cases, however is few and it would appear to be the exception to find a familial history rather than the rule. In no case in this series is there any evidence of an hereditary factor.

Schubert also cites as evidence of a constitutional cause the fact that after operative extirpation there is scanty regeneration. This would hardly seem to be a valid argument. He quotes Krogius and K. H. Bauer as authorities that the degenerative changes are indubitably due to faulty embryonic anlage but that they may be stimulated by trauma. He is not satisfied with this explanation but feels that there is a trophic inhibition of the central nervous elements ruling this faulty anlage. As additional evidence to support this theory he cites the association of other anomalies.

Bradford and Lovett quote Oiler, Golding Bird and Shaffer that the cause is an arrest of development of the sternomastoid muscle due to affection of the nerves or nerve centers. Campbell uses the inclusive term of error in development.

The relation of obstetrical injury to the deformity has been stressed. Stromeyer almost a hundred years ago advocated the theory that the underlying cause is rupture of the muscle at birth with formation of an hematoma. Confusion has resulted from the unwarranted consideration of the early enlargement of the muscle the so called sternomastoid tumor to be due to hemorrhage in the muscle. All of the older literature refers to this tumor as an hematoma and its existence was taken by some as evidence of the traumatic causation of the deformity. Jones and Lovett state "There are some hematomata without wry neck and some wry necks without hematomata but it must be regarded as one of the causes." They emphasize that the rupture may take place in a previously shortened muscle. Campbell considers that the condition resulting from hematomata should be considered as acquired rather than congenital, which argument has a certain amount of logic. Whitman summarizes the argument against hematomata as a cause in four points (1) rupture of other muscles does not cause myositis and contraction (2) Heller

has shown that experimentally a pyogenic infection is necessary to cause such a myositis and contraction (3) in a series of 55 cases of congenital torticollis only 7 gave history of birth injury (4) in 7 cases of hematomata of the sternomastoid during delivery none developed torticollis. Aberle quotes Peterson, Kredl, Friedberg, Spitzky and others who have reported hematomata not followed by torticollis. Keetley however followed 30 patients with hematomata and found 11 eventually developed a wry neck.

A recent very excellent study by D. Stewart Middleton from the Hospital for Sick Children, Edinburgh points out that the sternomastoid tumor lacks many of the characteristics of a hematoma. There is never any ecchymosis or fluctuation but from the onset the mass is firm, hard and cartilaginous to the touch. The process is diffuse instead of localized and further there is an interval of 1 or 2 weeks after delivery before the tumor appears which is not consistent with hemorrhage. Finally Middleton states that excision of the tumor definitely proves that it is not due to hemorrhage. On section the tumor shows a glistening fibrous tissue not unlike a soft fibroma. Histologically this is a young cellular fibrous tissue containing scattered degenerated muscle fibers. This same pathology was reported by von Lackum in a series of 4 cases in which he excised the mass.

Albee states that the condition is frequently although not always, associated with difficult delivery occasioned by dystocia from malpositions and malpresentations. He also observed association with obstetrical paralysis. In 2 cases in this series this combination of torticollis and obstetrical paralysis has occurred. Middleton observed 54 cases of Erb's paralysis seen from birth to 3 months and found 11 cases of "sternomastoid tumor."

Colonna contributes some statistics in regard to obstetrical history finding dystocia in 15 of 22 cases or 68 per cent. He reports one breech presentation in 51 cases which is less than the normal occurrence of 3 per cent. Rosenbaum reported 6 abnormal deliveries in 9 cases of torticollis including 3 forceps, a breech, and a frontal presentation. Against the argument of birth injury is the case re-

ported by Rossi delivered by caesarean section without trauma in which the deformity was marked. Middleton reports the obstetrical history of 64 cases. Of these, 43 were born of primipare, and of the 21 babies remaining, 16 were "difficult prolonged labors," "cross-births," or "breech presentations." Of 83 cases 14 had a normal labor, 46 were difficult or prolonged, 15 were breech presentations, and 8 were cross-births. Aberie in a series of 37 cases found 22, or 60 per cent with abnormal labor including 16 breech presentations, 1 face, and 5 forceps. In 5 cases there was no obstetrical history, and only 10 were said to be normal birth.

In this series, data as to the obstetrical condition was obtained in 35 cases. Fifteen had normal delivery, one of which was also stated to be easy. In 4, delivery was said to be difficult, in 1 of which the mother died. Six were instrumental deliveries, 3 of which were characterized as difficult. Ten were breech deliveries with 8 specifically stated as difficult instruments being required in 2 and labor unduly prolonged in 3. One child was 10 weeks premature weighing 5¼ pounds.

Combining the available statistics on obstetrics we find of 202 cases, 146, or 72 per cent are reported to have had difficult abnormal labor, and of 210 cases there were 43 breech deliveries, or 20 per cent. No other single finding was reported in enough series to be of significance.

Some authors have attempted to attribute torticollis to an infective agent. As previously stated, Whitman, in his arguments against trauma and hemorrhage, quotes Heller's experimental work that a pyogenic infection is necessary to cause a myositis. Mikulicz and Kader accepted this theoretical infection as the primary cause, but, as Albee pointed out, no organism has ever been shown to be present. Furthermore the pathological picture as well as the clinical course fails to support this theory. Albee also mentions, but does not support, the theory that the primary disturbance is a localized luetic sclerosis of the muscle. In our cases blood Wassermann reactions have not been taken, but none of the children have shown any suggestive stigmata of congenital syphilis.

The final theory which has been offered to explain the origin of this deformity is that it is produced by an ischemia due to prolonged partial obstruction of the blood supply, and represents a condition analogous to Volkmann's ischemic paralysis. Volcher, in 1902, and Nové Jossier and Vianny, in 1906, originally advocated this theory and it is supported by Albee. They point out the anatomical fact that certain positions through which the head may pass in delivery can readily obstruct the blood supply of the sternomastoid. Middleton assumes that the vascular interference is not arterial but is venous and quotes Jepson's observation that a venous blockage which has been complete for a few hours is capable of initiating a process of fibrosis which continues even after the obstruction has been relieved. Brooks has also experimentally produced an analogous condition in the sartorius of a dog by venous ligation. Middleton repeated this work, and demonstrated the same type of microscopic pathology as was found in the sternocleidomastoid in his cases of torticollis. In our opinion this theory is the most logical and best supported explanation.

#### PATHOLOGY

—BLOOD SUPPLY

The pathology has been described as a sclerotic interstitial myositis with Zenker's waxy degeneration producing dense induration and shortening. This condition is usually limited to the sternomastoid muscle, but in long standing severe cases the platysma, scaleni and splenius may be shortened (Albee). In 2 of our 35 operative cases, shortening sufficient to prevent correction was found on side of the sternomastoid. In 1 case this was in the scalenus anticus and in the other in the splenius capitis. In 2 of the non-operative cases the trapezius was definitely involved.

It has been our observation that frequently one part of the muscle will stand out much more definitely than the rest, and Howell states that the sternal head is more commonly involved. In our 57 cases no mention was made in 32 and in 2 it was noted that both the sternal and clavicular heads were contracted. Of the remaining 23, 16 showed primarily sternal head involvement and 7

clavicular In all cases however it was found that both components were to some extent deforming factors.

The pathology of the early stage as described by von Lackum and Middleton has already been stated The sternomastoid sheath is shown to contain a firm white glistening mass composed of a young cellular fibrous tissue containing scattered degenerated muscle fibers. The late picture seen in the developed case of torticollis as described by Middleton represents an end stage of this sternomastoid tumor Sections of this excised muscle show thick bundles of adult non-cellular fibrous tissue containing small muscle fibers scattered through it.

#### CLINICAL COURSE

The various texts state that the condition is noted at birth or soon after Colonna reports that 14 cases of a series of 51 were noted at birth while in 42 cases the average age was 11 to 12 months. He explains this extremely high average as due to the fact that several were reported as first noted at about 5 years, which seems inconceivable. Eliminating these cases the average is reduced to 3 months. Hellstadius, on the contrary emphasized the fact that frequently cases do not develop for many years after birth. Middleton also states that the clinical onset of deformity is often late usually at about 4 years in his experience. He explains this fact by pointing out that there is not an actual shortening at the muscle but an impairment of growth which prevents the muscle from keeping pace with the development of the rest of the cervical region Thus the deformity becomes clinically evident during the period of rapid growth.

Our experience agrees with that of Middleton and Hellstadius. Approximately 30 per cent of our cases were first detected soon after birth about 20 per cent more during the first year and in approximately 15 per cent the deformity was not observed until the child was nearly of school age and in 1 case not until the child was 7 years old. In 11 cases no history as to the first appearance of symptoms was obtained. In 14 cases the onset was given as birth in 5 cases "soon after birth" in 2 3 days 1 week 3 weeks 4 weeks and in

3 cases 1 month. Many of these cases presented on examination or gave a history of definite sternomastoid tumor In 11 more cases the deformity was noted during the first year These were noted as infancy "early infancy" under 6 months, 2 3 5 and 7 months each in one instance while 2 were observed at 4 and 6 months. In 5 cases the onset was in the second year in 4 in the third, in 5 in the fourth, and in 4 in the fifth. Two children were 5 years of age and 1 was 7 It is of interest that in one of the older children although the parents insist that no deformity was present before 4 years of age photographs taken in infancy show a definite inclination of the head to the affected side.

#### FACIAL ASYMMETRY

Of considerable importance and interest is the typical distortion and asymmetry of the face with general atrophy of the side of deformity Aberle Hoffa, and others have very aptly used the term "facial scoliosis" to describe this condition which is a constant finding when the deformity is more than of very short duration. The deformity is not limited to torticollis but may be caused by luxations, syphilitic or tuberculous disease of the spine, or scar contraction following trauma. Jones and Lovett state that this is due to circulatory abnormality but Walter has given a much more logical explanation based on the alteration of pressure and traction forces brought about by the permanent oblique posture. He also reports a very interesting case in which a left convex facial scoliosis in a case of right torticollis was converted into a right convex facial scoliosis by 17 weeks overcorrection. Hagen-Torn explains the progressive deformity as well as the facial asymmetry as solely due to the difference in growing power of the bone on the two sides. This power he assumes, is the resultant of the tissue tension produced by the growing bone and the inhibition produced by the shortened muscle. He has devised a very interesting model consisting of the skull and cervical vertebra mounted on a double spring The sternomastoid muscles are represented by elastic bands and the deformity is produced by shortening one band. On release of the upper spring, the deformity is

greatly exaggerated. He states that after operative release the potential energy of the growing part is converted into a kinetic energy, so that the affected side catches up with the normal side and thereafter proceeds in harmony with it. It is our impression that the asymmetry is roughly proportional to the age as stated by Walter and the severity of the deformity, although Aberle states that there is no parallelism between the degree of muscle change or deformity and the degree of asymmetry.

An attempt was made to estimate roughly the amount of facial asymmetry in this series. In 5 cases there was very little distortion, 3 being classified as mild, and 2 cases as slight. Of these 5 cases two were infants. In 22 cases the asymmetry was classed as moderate and in 17 as marked. The degree of deformity was also roughly estimated as extreme in 2 cases, marked in 15, moderate in 23, and mild in 2.

#### AGE AT OPERATION

It is of particular interest since all authorities agree in the desirability of early treatment that no case in this series had received the benefit of any treatment, previous to admission. Aberle, in an operative series of 37 cases from Germany, reported approximately half the cases under 1 year (20 cases), one quarter between 1 and 6 (8) and one-quarter between 6 and 14.

In this series of 39 cases, only 4 were in infants. These cases were 6, 9, 10, and 18 months. The remaining 90 per cent varied from 5 to 14 years and averaged a little over 9 years. The ages were 5 (2 cases), 6 (2 cases), 7 (7 cases), 8 (5 cases), 9 (4 cases), 10 (2 cases), 11 (2 cases), 12 (6 cases), 13 (3 cases), and 14 (2 cases).

#### NON-OPERATIVE TREATMENT

In considering the non-operative treatment in this series, it is important to remember that most of our cases were fairly well along in childhood and had no previous treatment. Campbell states that non-operative treatment results in correction in a large proportion of cases under one year. Colonna finds methodical stretching usually all that is required

under 6 months, while in a total series of 269 cases 140 (52 per cent) were satisfactorily treated by this means. Howell feels that all early cases can be cured by manipulation within 3 months. Von Lackum, on the contrary, advises early operation as does von Landgraf.

In 8 cases, operation was not advised and treatment by manipulation and stretching was carried out at home and in the Out Patient Physiotherapy Department. In one case a Thomas collar was also used. These cases were all in young children, treatment being started at 5 weeks, 3 months, 6 months, 7 months, 15 months, 2 years, and 3 years in 2 cases. In the three oldest cases the deformity was slight and in 1 had been previously treated elsewhere by stretching. In all of these cases the results are satisfactory to date. Complete active and passive overcorrection was obtained in from 3 months to 1 year, and this with a disappearance or decrease of the cranial and facial asymmetry has been maintained in 6 cases from 1 to 6 years. The follow up period has been 1 year in 1, 2 years in 2 cases and 4, 5 and 6 years in 1 each. Opposed to these 8 cases there have been in this series 3 operative cases 1 year old or younger. Possibly non-operative treatment might have been satisfactory in these cases but it was not elected because of the severity of the deformity and the home situation.

Rosenbaum has advocated a chemical treatment designed to soften the cicatricial tissue. This consists of the injection of a 1 per cent solution of pepsinum purissimum in Pregel's iodine solution according to the method of Payr. At first 0.5 cubic centimeter and then 1 cubic centimeter was injected twice weekly directly into the tumor. Altogether 15 to 6 cubic centimeters were used. He reported immediate results in all of 9 cases, 3 of whom showed complete functional cures when examined at the end of one year. We have had no personal experience with this method of treatment.

#### OPERATIVE TREATMENT

Lorenz advocated subcutaneous rupture or myorrhesis. This is condemned by Steindler as dangerous and obsolete. The procedure has

not been attempted in this series because of our theoretical agreement with Dr Steindler. Subcutaneous tenotomy has also been advocated but we have not used it because we have felt that it would be insufficient to permit correction. Howell reports 23 operations on late cases in which subcutaneous tenotomy was done on the sternal head and two by open division. One case of twenty-one done subcutaneously failed to give a complete cure and a secondary open division of the origin of the muscle was done with good result.

Open division of the origin of the muscle is the usual method of correction. Lange originally advocated division of the insertion below the mastoid as quoted by Bradford and Sever which has been recently advocated by Hellstadius with subcutaneous sternal tenotomy in milder cases, particularly because of the hidden scar above the hair line. Mikulicz advised resection of the muscle. Jones and Lovett also describe a method of plastic lengthening of the middle portion of the muscle similar to the technique more recently advocated by Hagen Torn. The tenoplastic method of Foederl consists of division of the origin with suture of the clavicular to the sternal head. Albee states that kneading of the muscle must be performed after division at the same time traction is made on the arm and head.

The after treatment is emphasized as of utmost importance by most authors and consists of a period of fixation followed by massage and exercises. Albee and Whitman recommend fixation for 4 to 8 weeks. Steindler from 2 to 3 months and Jones and Lovett, from the day after operation for at least 6 weeks. Hagen Torn however feels that these procedures are definitely harmful after 1 week. He urges faradization and massage on removal of stitches followed by active exercises.

The operative procedures in the cases of this series have consisted of division of both the sternal and clavicular origins of the muscle and when necessary a subcutaneous tenotomy of the insertion was also done. A partial division of the scalenus anticus was necessary in 1 case and of the splenius capitis in another. In 10 cases approximately 2 centimeters of the sternal head was resected in order to obtain

adequate overcorrection and in 2 cases about 1 centimeter of the clavicular portion was excised. These cases were among the earlier ones of the series and this resection has since been abandoned for two reasons. First, it is usually not necessary for complete and permanent correction and second, the absence of the normal prominence of the sternal head leaves a permanent asymmetry of the neck which is cosmetically undesirable. In 3 of these 12 cases with resection the insertion was tenotomized.

In order to avoid the disfiguring loss of the sternal head attempts were made to preserve it in so far as was found compatible with correction. In 1 case nothing was done to the sternal head the clavicular head or origin being divided and the insertion tenotomized. In 7 cases the sternal head was lengthened by partial transverse incisions at two levels and the clavicular head divided. In 4 of these the insertion was also tenotomized.

In 19 or about half the cases both the sternal and the clavicular heads were completely divided and in 6 of these a subcutaneous tenotomy of the insertion was combined. In the entire operative series, the insertion was divided in 14 cases, 36 per cent of the series.

In all the cases particular attention was given to obtaining the least possible scar. A minimal skin incision of about 2 or 3 centimeters was made obliquely below and to the outer side of the sternal end of the clavicle in the line of the skin fold. The loose tissue permits adequate exposure of the entire origin of the muscle through this incision. The superficial fascia is closed with interrupted sutures of No. 00 plain catgut and the skin sutured with a subcuticular stitch. In spite of the fact that the wound is placed under tension in correcting the deformity only three scars have been at all objectionable. One case shows a definite keloid, one a slight keloid and one some broadening of the scar. In the remaining 92 per cent the scars are small, freely movable and not disfiguring.

The postoperative fixation was by plaster helmet in 19 cases, plaster collar in 9, Thomas collar in 2, brace in 2 and sponge rubber crutch top as pad in 2. Head traction was ap-

plied in 5 cases. This was used for about 1 week in 4 patients and continued for a month in the other case. This was followed by plaster helmet in 4 cases and by a brace in the other. The time of application of fixation varied from 2 to 9 days after operation. The duration of fixation varied from 3 weeks to 5 months, and 1 exceptional case in which there was a marked high scoliosis had 14 months fixation. The usual period of fixation was about 6 weeks.

Following the removal of fixation, all children have been given physiotherapy consisting of active and passive stretching, sometimes with suspension corrective exercises, massage, and sometimes baking. When possible these treatments were carried on in the clinic about twice a week for from 1 to 3 months, followed by once a week or once every 2 weeks for another 3 to 6 months. In those instances in which the child could not be brought to the physiotherapy department, the mother and child were carefully instructed in carrying on the treatment at home. Although no supporting evidence can be adduced from these cases it is our opinion that this part of the after treatment is of great importance.

#### RESULTS OF TREATMENT

Oser in discussing this condition, states that it is unimportant as it is readily relieved by tenotomy but he quotes Golding Bird that the facial asymmetry persists "or, indeed becomes more evident." Albee states the facial asymmetry persists from 2 to 3 years after correction but gradually disappears. Aberle states that the facial asymmetry usually disappears after operation but good results are to be expected only prior to 5 years of age since at this age the growth of the skull practically ceases. Beck, on the other hand, claims that facial asymmetry does not disappear after surgical treatment. Meyerding reported 26 cases of open tenotomy with 14 cured and 4 improved, i. e., 8 cases (30 per cent) unimproved. Steindler reports 27 operations 6 of which were for other conditions than congenital torticollis according to his classification. With the standard as good active and passive overcorrection his immediate results were good in 88 per cent, poor in 12 per cent and the remote results were good in

77 per cent and poor in 23 per cent. He attributes his failure to "error in technique in 2 cases, and inability to correct due to severe respiratory embarrassment in another." He does not state whether these failures were in the congenital group.

In our cases 35 have been followed from 1 to 7 years after operation, while 4 were under 1 year when last seen. In the recent cases the time interval is too short to estimate the result. Of the 35 cases followed more than 1 year 12 are under 2 years, 8 between 2 and 3 years, 9 between 3 and 4 years, 2 between 4 and 5 years and 4 more than 5 years. All show good active and passive overcorrection of the deformity. One case has some residual cervicodorsal scoliosis which is perhaps paralytic in origin. Sixteen cases show a prominent residual band on complete overcorrection. In 2 cases in both of which muscle was resected secondary operation was seriously considered at one time namely 1 to 4 months after operation in the first and 3 to 5 months in the second. In neither case has there been any recurrence of deformity. The band stretched out and no additional surgery became necessary.

In 3 cases this residual or recurrent band in the clavicular portion of the muscle was sufficient to require tenotomy. This was done 1 year after the original operation in 1 instance and after 3 years in 2 cases. Including these cases the band was in the clavicular portion of the muscle in 13 cases and usually well toward the lateral border of the muscle. In 2 cases the band was in the upper part of the muscle and in 1 instance it was in the sternal head.

We have already referred to the unsightly prominence of the inner end of the clavicle and the asymmetry of the neck produced by loss of the sternal head. This is present in 12 cases or one third of our series. We feel that this should be emphasized because it can be avoided in most cases without jeopardizing the results. The loss involves no functional disability but particularly in the female it is cosmetically undesirable.

In most cases we have observed a very rapid improvement in the facial asymmetry during the first 6 months following the initial ap-

parent increase. This immediate change is of course not real but because of the assumption of correct head posture the pre-existing change is made more obvious. After the first 6 months, the spontaneous correction apparently becomes slower and although 2 cases showed a complete return to normal in 1½ years a little difference can usually be detected up to 4 years. As would be expected the improvement in facial asymmetry appears to be more rapid in the younger children but this could not be quantitatively expressed. In all cases the greater part of the asymmetry was corrected in 2 to 3 years and most of the children followed more than 3 years present no greater asymmetry than is often seen in normal children.

#### SUMMARY

1 This study is based on a series of 57 cases of congenital torticollis which represents an incidence of 2 per cent of the admissions of an orthopedic hospital during the past 8 years. This incidence is much higher than previously reported in the literature and has been progressively increasing at this institution.

2 There is no sexual nor racial predisposition.

3 The right sternomastoid muscle is slightly more commonly involved than the left.

4 The deformity is frequently though not necessarily associated with a history of some sort of obstetrical difficulty.

5 While no proof or additional evidence on the problem of pathogenesis is adduced, the explanation of ischemic fibrosis based on venous obstruction seems most acceptable.

6 Contrary to previous writers, it is our opinion that in many of the cases the deformity does not become apparent until late infancy and early childhood.

7 The results obtained by repeated manipulative stretching in infancy are frequently satisfactory.

8 In older cases, some method of surgical division of the sternomastoid muscle is necessary.

9 Complete excision of the sternal head of the sternomastoid causes an asymmetry of the neck with loss of normal contour and a marked

prominence of the sternal extremity of the clavicle. This cosmetic defect can be obviated by plastic lengthening of the tendon.

10 Postoperative treatment is of importance.

11 Full active and passive overcorrection of the deformity was obtained in all cases in this series.

12 Facial asymmetry is more obvious immediately after correction but then improves rapidly for about 6 months. Subsequently there is slower improvement usually becoming complete or nearly complete in about 3 years.

#### BIBLIOGRAPHY

- ABERLE, W. *Ätiologisches zum Schiefhals*. *Ztschr. f. orthop. Chir.* 1917, xlix, 27-43.
- ALLEN, FRED A. *Orthopedic and Reconstruction Surgery*. 1st ed. p. 939. Philadelphia. W. B. Saunders Co., 1921.
- BECK, O. *Die Ursache der Gesichtssymmetrie beim muskulären Schiefhals und Luxationen*. *Ztschr. f. orthop. Chir.* 1923, xlix, 424-449.
- BRADFORD, E. H., and LOWRY, R. *Orthopedic Surgery*. 2nd ed. New York. William Wood & Company.
- BRADFORD, E. H., and SEVER, J. W. *Boston M. & S. J.* 1907 August 22.
- BROOKS, B. *Pathologic changes in muscle as a result of disturbances of circulation*. *Arch. Surg.* 1922, v, 135-216.
- BROWN, BUCHHEIMER. *Orthopedic Surgery*. Boston. David Clapp & Son, 1868.
- BROWN, J. K. *Torticollis successfully treated at the Boston Orthopedic Infirmary*. *Boston M. & S. J.* 1822, xxvi, 55-60.
- CAMPBELL, WILLIS. *A Text Book on Orthopedic Surgery*. 1st ed. p. 662. Philadelphia. W. B. Saunders Co. 1930.
- COLONNA, PAUL C. *Congenital torticollis*. *Virginia M. Month.* 1927, xlii, 794-796.
- ELONOV, S. *Torticollis congenital, causé par des déformations des vertèbres*. *Acta orthop. Scand.* 1930, l, 75-78.
- FOERSTER, O. *Ueber Caput obstipum musculare*. *Arch. d. Geh. d. klin. Chir.* 1903, 317.
- GOLDENBERG-BREN. *Guy's Hosp. Rep.*, 1890.
- GUTH, S. K. *Bilateral torticollis*. *Indian M. Gaz.* 1930, lvi, 15.
- HAGEN-TORRE, J. *Die Lösung des Problems über die Entstehung der Schädelsymmetrie und Skoliose bei Caput Obstipum. Die Beseitigung derselben durch die Operation nach meiner Methode*. *Arch. f. klin. Chir.* 1930, cxliii, 35-64.
- HELLER. *Deutsche Ztschr. f. Chir.* xlix. Quoted by Albee.
- HELLSTROM, A. *Torticollis congenita*. *Acta Chir. Scand.* 1927, lxxi, 386-393.
- HOFER, A. *Zur Behandlung des hochgradigen Schiefhalses nach Albinus*. *Chir. Kongr.* 1905, II, 340.
- HORNBAKE, G. *Ueber den muskulären Schiefhals*. *Verhandl. d. deutsch. orthop. Gesellsch.* 1923, Kong. 1929, pp. 1-6-144.

30. HOWELL, B. W. The treatment of torticollis. *Brit. M. J.*, 1920, ii, 714-716.
31. HUTTEN, K. Ueberwiegens der rechten Seite beim muskulären Schiefhals. *Deutsche Ztschr. f. Chir.* 1939 cxviii, 422-424.
32. JEFFERSON, P. N. Quoted by Middleton.
33. JOACHIMSTAL and VOLCHER. *Handb. f. orthop. Chir.* 1904, p. 432.
34. JONES, SIR R. and LOVETT, R. *Orthopedic Surgery* 12d ed., p. 535. New York: William Wood & Company, 1923.
35. KROGG. *Deutsche Ztschr. f. Chir.*, 1904, 78.
36. KROGG, A. Torticollis. *Acta chirurg. Scand.* 1924 lvi, 497.
37. VON LANGGRAB, E. Ueber Frühoperation des angeborenen muskulären Schiefhalses. *Ztschr. f. orthop. Chir.*, 1927, xlviii, 39-45.
38. LOEWENTZ, A. *Wien. Med. Presse*, 1902, 235.
39. MAYERHOF, H. W. Torticollis. *Am. J. Orth. Surg.* 1911 xix, 91.
40. MINNERTON, D. S. The pathology of congenital torticollis. *Brit. J. Surg.*, Oct. 1930, xviii, 288-304.
41. MIKULIC, J. Ueber die extirpation des Kopfnickers beim muskulären Schiefhals, nebst Bemerkungen zur Pathologie dieses Leidens. *Zentralbl. f. Chir.* 1895, xxii, 1.
42. NOVÉ JOSEPH, and VIANEY CHARLES. Pathogenie du torticollis congenital. *Rev. d'orthop.* 1906 vii, 397.
43. OCKER, SIR WILLIAM. *The Principles and Practice of Medicine*. 8th ed. p. 1052. New York: D. Appleton & Co., 1910.
44. Idem. *New York M. J.*, 1891, December 12.
45. REBARD. *Le Torticollis*. Paris, 1898.
46. ROSENBAUM, S. Zur Behandlung des angeborenen Schiefhalses. *Monatschr. f. Kinderh.* 1920, xiv, 242-248.
47. ROSSI, D. Un caso di torcicollo congenito in un feto estratto con parto cesareo. (Contributo all'etiogenesi del torticollis). *Riv. d'ostet.*, 1928, x, 277-282.
48. SCHUBERT, A. Zur Aetiologie der Schiefhalskrankung. *Arch. f. klin. Chir.* 1927 cxlii, 646-657.
49. SCHULZE, W. Caput Obstipum Congenitum. *Deutsche Ztschr. f. Chir.* 1927 cclv, 347-355.
50. SHAFFER, NEWTON. *Tr. Am. Orthop. Ass.* vi, 305.
51. STRINDLER, A. *A Textbook of Operative Orthopedics*. 1st ed. p. 58. New York: D. Appleton & Co., 1925.
52. STROMMEYER, G. F. Beiträge zur operativen Orthopaedik oder Erfahrungen ueber die subcutane Durchtrennung verkürzter Muskeln und deren Sehnen. *Hannover Helwing*, 1838.
53. TURBY, A. H. *Deformities and Diseases of Bones and Joints*. 2d ed. p. 56. New York: Macmillan, 1912.
54. VON LACKUM, H. L. Torticollis, removal in early life of the fibrous mass from the sternomastoid muscle. *Surg. Gynec. & Obst.* 1920, xlviii, 691-694.
55. WALTER, H. Die Entstehung der Gesichtsmaskose bei muskulärem Schiefhals. *Verhandl. d. deutsch. orthop. Gesellsch.* (1927) Kong. 1928, xxx, 414-422.
56. Idem. Ueber Form und Ursache der sogenannten Gesichtsmaskose beim muskulären und beim Schiefhals aus anderer Ursache. *Arch. f. klin. Chir.*, 1920, cliv, 32-65.
57. WARREN, J. M. Division of the sternomastoid muscle for wry neck. *Boston M. & S. J.*, 1841-1842, xxv, 121-126.
58. WHITMAN, R. *A Treatise on Orthopedic Surgery*. 6th ed. Philadelphia: Lea & Febiger, 1919.



# CLINICAL SURGERY

FROM THE WESTERN RESERVE UNIVERSITY

## RECONSTRUCTION OF THE VAGINA

EMPLOYMENT OF THE FLAP TRANSPLANTATION METHOD IN ONE STAGE WITH A FAVORABLE ANATOMICAL RESULT

MARION DOUGLASS, M.D. F.A.C.S., CLEVELAND, OHIO

From the Department of Obstetrics and Gynecology, Western Reserve University School of Medicine and the Lakeside Hospital

**S**URGICAL reconstruction of the vagina in selected cases of congenital or acquired absence is a problem which has been attacked by a variety of operative methods. The early attempts to form the vagina by transplantation of adjacent skin surfaces as free grafts covering the walls of an opening made in the rectovaginal space universally resulted in failure owing to scar tissue contraction. The operative procedures employed have resolved themselves into three groups: (1) resection of the rectum and employment of a resected piece of rectum (Schubert), (2) resection of a loop of small bowel (Baldwin), (3) transplantation of skin flaps (Graves, Frank, Geist, et al.) Pemberton has very adequately summarized the situation in his survey of methods employed up to date. Dupuytren is credited as having made the first reported attempt to form an artificial vagina in 1817. Many different methods have been tried since, notably free skin flaps, Thiersch grafts, and intestinal wall as free grafts, and all of these have been unsuccessful. Gersuny and Puppl preceded Baldwin, who described his method in 1904 and carried it out in 1907. Mori performed practically the same procedure in Japan.

The next advance was Schubert's resection of the rectum and its employment as vagina in 1911. By this method the distal rectum is mobilized inside the sphincter, resected at an appropriate length and drawn in to form a lining for a previously made opening in the rectovaginal septum. The upper segment is drawn down and attached inside the sphincter, thus restoring the continuity of the large bowel. According to Pemberton's report, Schubert had collected 34 cases up to 1911 with a mortality of 12.5 per cent. Two deaths were due to peritonitis, although the operation is presumably carried out extraperitoneally.

The Baldwin operation has produced, in 79 reported cases, quoted by Pemberton, a mortality of 17.5 per cent. The admonition that only experts should perform this operation is invalid as no one is apt to see enough cases to acquire an adequate technique. High mortality rates are apparently not the only contra-indication, partial incontinence of feces frequently resulting after Schubert's method. Annoying discharge has been noted as a complication where intestine is transplanted in forming an artificial vagina. Ritchie reports an adenocarcinoma developing in a transplanted loop of small bowel (Baldwin operation). This must be considered, as the tendency toward malignancy in transplanted or misplaced tissue is well known.

The tendency recently has been toward the third method, i.e. transplantation of skin flaps. Mobilization of healthy flaps composed of skin of the inner surfaces of the thighs, and employment when feasible of the labia minora as all or a portion of the vagina, has come to be more frequently tried than the radical procedures of bowel resection. The mortality rate is reduced by this method to a negligible level, and the operation can be performed with relative ease. The end-result of any technique for reconstructing the vagina is somewhat problematical, and it seems doubtful whether subjecting a patient to a high mortality risk is justifiable. The technique of the skin flap transplantation devised by Graves, described in his textbook and employed successfully in 1 case, has been the basis of several similar procedures. He used four racket-shaped flaps to fill a cavity made by blunt dissection between the vagina and rectum, obtaining two of the flaps from the medial surfaces of the thighs, and two from the labia minora. The flaps were sutured together over a glass form and invaginated into the cavity. The

method, if properly performed, is effective, although prone to contraction until healing has taken place.

Frank and Geist have devised a plan of producing a tubular skin flap and this has been successful in several cases. A tubular graft is made in stages from the skin of the inner surface of the thigh. This is gradually freed and, becoming well vascularized from its pedicle alone, is eventually turned in to form a lining for the prepared opening. It is necessary of course to perform this procedure in stages, but the nutrition of the tubular flap is well preserved thereby and the liability of sloughing is reduced. Modification of the same principle, i.e. the construction in numerous stages of a well nourished tubular flap also from the inner aspect of the thigh, has recently been reported by Grad. These methods, however, require multiple operations—a serious disadvantage. Davis and Cron described a technique employing the principle of Graves' operation using two flaps prepared entirely from labia minora. This method, consisting of immediate transplantation of thick flaps with broad bases, is a simple procedure possible of performance in one stage but subject to the danger of distal ischaemia of the flap, with subsequent contraction, especially at the apex of the new vagina. This operation was performed in a single case coming under our observation, with an excellent plastic result.

#### CASE REPORT

The patient was an 18 year old white female who entered the Lakeside Hospital August 2, 1931 with a diagnosis of acute appendicitis. Immediate appendectomy was performed. An attempted pelvic examination at this time revealed complete absence of the vagina. The labia minora and labia majora were rather small. The clitoris was slightly larger than normal in size (see Fig. 1). Upon rectal examination the uterus also was found to be apparently missing. There had been no menstruation and a complete absence of menstrual menses. Rectal examination under anesthesia revealed in the right adnexal region an ovokid mass, firm and freely movable, apparently the right ovary. This was slightly larger than normal in size. The vaginal orifice showed a small dimple at the normal site of the vagina, approximately 1 centimeter deep the bottom of which was solid. The patient was a well developed, well formed, attractive girl with normal development of the breasts. There was normal distribution of hair and apparently typical feminine habitus in all respects. The patient had no subjective symptoms suggestive of any cyclic menarchal activity. She was not tested for female sex hormone.

The situation was explained to the patient and it was suggested that after successful plastic operation it might be possible for her to marry and lead a normal social life. The patient's psychosexual reactions toward the male were typically feminine.

**Operation.** A transverse skin incision was made in the area between the rectum and the urethra.

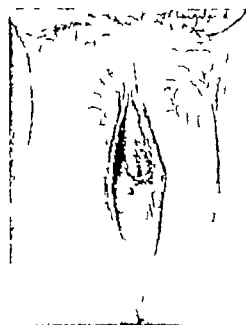


Fig. 1 Perineum before operation.

which were in exceedingly close approximation. A sound was placed in the urethra, which was held by an assistant, and the index finger of the left hand was placed in the rectum. By blunt and sharp dissection a cavity was made, the length of the index finger between the bladder and the rectum which corresponded in position with the normal vagina. Sufficient retraction was obtained to permit much of this to be done under sight. Several vessels were of sufficient size to make ligation necessary. The cavity was made and dilated to admit two fingers with slight difficulty. The immediate proximity of the rectum and urethra made greater dilatation seem dangerous. The peritoneum was visualized at the apex of the pouch so made. Two sutures were placed firmly in the apex of the false passage made between the rectum and the bladder. The labia minora were excised from above downward then split and flattened out, producing racket shaped pedicle flaps. A rather large pedicle was left for attachment to insure fair blood supply (Fig. 2a) these were used as the two upper flaps. At a level just above the base of the posterior surface of the new vagina, two racket shaped flaps 4 inches in length and 1.5 inches in width were prepared on rather broad pedicles, from the inner margin of the skin of the thigh. These areas showed a minimum of hair growth. An everted pocket was easily formed by suture of these four flaps turned on their pedicles in the manner suggested by Graves and by Davis and Cron although the latter employed the labia only (Fig. 2b). The sutures originally placed in the depth of the cavity were passed through the

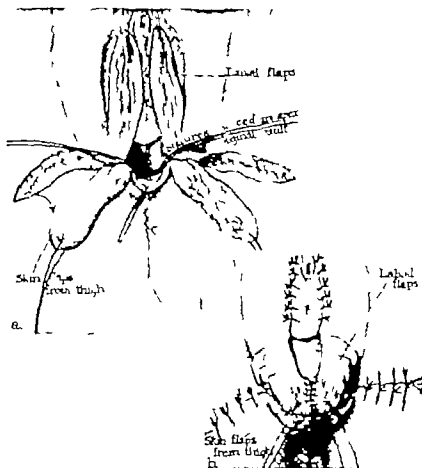


Fig. 2. a, Skin flaps mobilized b, Partial suture of flaps forming everted vagina.



Fig. 3. The flaps have been sutured and have been drawn into place.



Fig. 4. Appearance of vagina admitting a finger to a point above the knuckles.

apex of the everted lining and this was turned into the vagina and held firmly by tying the sutures, a single end of which was passed through each of one of the four flaps (Fig 3). The vagina was packed with vaseline gauze. A retention catheter was kept in the bladder until the twelfth day after operation. The gauze was removed on the second day after operation. Additional examination was done on the eleventh day following subsidence of swelling. At the time of the patient's discharge from the hospital, 1 month from date of operation, the vagina was as long as the index finger. There was an area of granulation at the apex of the vaginal canal which could be felt as a rough area and it was impossible to insert two fingers without causing pain. This patient was kept under observation for a year and examined regularly for 6 months until the period of rapid contraction was over. The vagina was systematically dilated by digital examination every 2 weeks and by daily passage of dilators 3 to 4 centimeters in diameter by the patient. One year after operation the patient had a vagina 3.5 inches in length admitting two fingers freely, potentially longer due to the fact that there is a great deal of resiliency and 'give' in the new vagina without pain (Fig 4). This patient is still single but has a fairly normal vagina capable of reasonably normal function. There is apparently normal clitoris sensibility. It was impossible to determine any transfer of erogenous sensibility to the recently constructed vagina. However, high digital dilatation of the vagina without palpating of the clitoris was characterized by the patient as vaguely pleasant. Tendency toward scar tissue contraction seemed to have disappeared.

#### CONCLUSIONS

Plastic construction of the vagina by transplantation of plastic skin flaps seems to be preferable

to more dangerous gut transplantation operations if only on the basis of comparative mortalities. In spite of vigorous championship of gut resection methods by originators of various techniques it seems preferable that good results be sought after by careful and painstaking transplantation of the thigh skin and labia minora, in the form of pedicle grafts. The sole but highly important objection to this safe easily performed procedure is of course contraction which can be reduced to a low level by care in the planning and execution of the operation.

#### BIBLIOGRAPHY

1. BALDWIN J. F. Artificial vagina by intestinal transplantation. *J. Am. M. Ass.* 1910, liv, 1362.
2. HALDWIN J. F. and ABBOTT A. W. The Baldwin operation for artificial vagina. *Surg. Gynec. & Obst.* 1918, xxvii, 631.
3. DAVIS, C. H. and CRON R. S. Congenital absence of the vagina. report of two cases treated by vaginal plastic operation. *Am. J. Obst. & Gynec.* 1928 xv, 196-201.
4. FRANK, R. T. and GEIST S. H. The formation of an artificial vagina by a new plastic technic. *Am. J. Obst. & Gynec.* 1927 xiv, 712-718.
5. Idem. Additional reports on satchel handle operation for artificial vagina. formation of artificial vagina by new plastic technic. *Am. J. Obst. & Gynec.* 1932 xxxiii, 256.
6. GRAD HERMAN. The technique of formation of an artificial vagina. *Surg. Gynec. & Obst.* 1932 liv, 200.
7. PEMBERTON F. A. Formation of artificial vagina. *Am. J. Obst. & Gynec.* 1925 x, 294.
8. RABINOVITCH C. N. Formation of an artificial vagina. contribution to 25th anniversary of Baldwin operation. *Am. J. Surg.* 1931 xlii, 480.
9. RITCHIE, R. N. Primary carcinoma of the vagina following a Baldwin reconstruction operation for congenital absence of vagina. *Am. J. Obst. & Gynec.* 1929 xviii, 794.
10. SCHUBERT G. Concerning the formation of a new vagina in the case of congenital vaginal malformation. *Surg. Gynec. & Obst.* 1914, xix, 376-383.

## ACUTE OSTEOMYELITIS OF THE ILIUM

FORREST YOUNG, M.D. ROCHESTER, NEW YORK

From the Department of Surgery, Division of Orthopedics, The University of Rochester School of Medicine and Dentistry

ACUTE osteomyelitis of the ilium is represented by a relatively short bibliography covering the last 30 years. This would lead one to believe that the disease is rare. While the condition is by no means common, its occurrence does not deserve surprise. Geist during a period of 5 years, saw 3 acute and 2 chronic cases of osteomyelitis of the ilium; he concluded that the affection was not so rare as is generally supposed.

It is, of course, well known that acute osteomyelitis of the short and flat bones is much less frequent than that of the long bones. Froehner in analyzing 545 cases of osteomyelitis found that 51 of them were of the short and flat bones; a ratio of 1:12. He further noted that in these 51 cases of short and flat bone osteomyelitis, the ilium was next to the clavicle in frequency of involvement.

At the 1915 Russian Surgical Congress in Leningrad Krasnobajin reviewed 428 cases of osteomyelitis treated in 20 years. Twenty patients had osteomyelitis of the ilium; that is, 5 per cent of the total number. Buossant reviewed 170 cases of osteomyelitis treated during a period of 14 years; of these 4 were acute osteomyelitis of the ilium; 2.3 per cent. Simmons reported 2 cases of a total of 97 cases of osteomyelitis studied; 2.05 per cent. Bearse gave the frequency of occurrence as 2 to 7 per cent of all bones. Flickinger reported the same figure. Both Bearse and Flickinger stated that osteomyelitis of the ilium comprises 20 per cent of all flat bone infections.

If acute osteomyelitis of the pelvic bones alone is considered it is found that the ilium is much more frequently involved than the pubis and ischium. Monastegou states that "it is located most often in the ilium, sometimes in the pubis, very rarely in the ischium." He was able to compile 11 cases involving the ilium during a period of 13 years in the Infantile Surgical Clinic of the Faculty of Paris. VonBergmann collected 71 cases of osteomyelitis of the pelvis; of these 63 were of the ilium alone. Thomschke concluded that primary osteomyelitis of the pubis and ischium is a rare disease.

From a review of the literature we can draw the following conclusions as to the frequency of occurrence of osteomyelitis of the ilium. It comprises about 5 per cent of all osteomyelitis, it is

the most frequently affected flat bone accounting for about 20 per cent of all flat bone osteomyelitis, that of the bones of the pelvis it is by far (83) the most common site for the disease.

During the past 5 years, 11 cases of osteomyelitis of the ilium have been treated in this clinic. Of these 5 have been chronic; 2 were metastatic during the course of acute osteomyelitis in long bones, and 1 was a tuberculous osteomyelitis. These cases are not included in this report as they present different problems both as to diagnosis and treatment.

The 3 following cases of acute primary osteomyelitis of the ilium illustrate the difficulties of diagnosis, the common confusion of the disease with pyogenic infection of the hip joint, the problems encountered in treatment, and the long continued course of the malady. The two surviving cases show the end result 2 years and 9 months, respectively after onset. Of the case reports found in the literature, very few include the end-result for any considerable length of time after onset. It is hoped that the reports below may be of some help in determining the ultimate prognosis in similar cases.

## CASE REPORTS

CASE I. S. M. H. No. 222 a Jewish boy aged 16 years, entered Strong Memorial Hospital, February 27, 1926. He complained of pain in the right hip, right great toe, and sternoclavicular joint; weakness and shortness of breath. Eleven days before entry the patient went skating. On returning home he complained of pain in the right hip. That evening he had chills and vomited. The next day he was feverish and complained of generalized dull aching in all his joints. On the third day of his illness his mother noted that his urine was red and on the sixth day it was black. During this same period his skin became yellow and he began to be short of breath. His bowels were quite loose, the feces were black in color. He had 3 hemorrhages from the nose; the last of which lasted 6 hours. On the sixth day of the illness he began to complain of pain in the episternal notch and right great toe. He developed very small, red papules over the lower limbs. During the illness he had been seen by several physicians. His temperature had always been 103-104 degrees F. He had continued throughout the illness to complain of pain in the right hip. He entered the hospital by stretcher on the eleventh day of his illness.

Physical examination on entry revealed a boy very acutely ill, with temperature 39.5 degrees C. He lay in bed appearing exhausted. He was breathing at the rate of fifty times per minute. The breath was sour and the tongue was heavily coated. The conjunctivae were pale; the skin and sclerae slightly icteric. The nose contained dried crusts of blood. The heart was enlarged. There was a palpable and

sensible pericardial friction rub. The pulse was regular 130 per minute. The blood pressure was 118/40. There was widening of the mediastinal dullness to 10 centimeters in the second intercostal space. The lungs were clear. The spleen and liver were both enlarged and tender. Rectal examination showed no masses. Over the lower limbs there were numerous small, red, itchy papules, with purulent centers. In the episternal notch there was a small red swelling which was very tender. The metatarsophalangeal joint of the right great toe was swollen red tender and painful on motion.

The region about the right hip joint was tender to palpation. There was no visible or palpable swelling. The lower extremity lay on the bed in normal position. The joint could be moved passively throughout almost its complete range of motion with almost no pain. No muscle spasm was found.

Laboratory examination revealed hemoglobin 40 per cent; red blood cells 2,900,000; white blood cells 50,000. Differential count showed 97 per cent polymorphonuclears. The urine was cloudy brown, with trace of albumin, no sugar. Microscopic examination showed many red cells and granular casts. Blood culture: hemolytic *Staphylococcus aureus*. Culture from papule on lower extremity showed the same organism. Wassermann reaction was negative. Widal, negative. X-rays of the chest showed a hyperinflated and dilated heart.

The day after admission the swelling in the episternal notch became fluctuant. It was incised and 150 cubic centimeters of thick pus drained off. *Staphylococcus aureus* was recovered from this on culture. Following this the patient was transfused with 400 cubic centimeters of citrated blood. The next day he was given by the medical service 300 milligrams of gentian violet in solution intravenously without reaction. On the following day he seemed improved and the temperature was slightly lower. It was decided to withhold another transfusion or tapping of the pericardium until the temperature should swing up again. That night the patient suddenly became very dyspneic and distended. The distention recurred as quickly as it was relieved. Stimulants were of no avail. Within an hour he was dead.

Postmortem examination disclosed the following: There was a large abscess in the upper mediastinum which had been drained but still contained 75 cubic centimeters of pus. There was an abscess under the left pectoral muscles. The pericardial cavity contained 60 cubic centimeters of yellow cloudy fluid. There was a thick fibrinous pericarditis. The lower lobes of both lungs showed a typical compression atelectasis. The spleen was about five times normal size and contained a large infarct. The liver was enlarged by about half but contained no abscesses. Both kidneys contained innumerable milium abscesses. The lymph nodes at the hilus of the lung and the retroperitoneal lymph nodes were greatly swollen. On the right side of the true pelvic cavity the wall was seen to bulge. Incision of this exposed a large abscess. It was found to come from beneath the iliacus muscle and to overlie an extensive osteomyelitis of the entire wing of the right ilium. There was a great deal of bone destruction. The cortex of the ilium was moth-eaten with the underlying bone soft and necrotic. The lesion in the iliac bone was interpreted as being the oldest.

The final diagnosis was acute primary osteomyelitis of the right ilium followed by *Staphylococcus aureus* septicemia with subsequent metastases to the pericardium, mediastinum, spleen, kidneys, left subpectoral region and metatarsophalangeal joint of the right great toe.

The first case is that of a boy of 16 years who, following a probable trauma sustained while

skating complained of pain in the right hip. He rapidly developed the signs of an overwhelming blood stream infection. On examination 11 days after onset the boy was seen to be desperately ill. The temperature was 39.5 degrees C. white blood cells 50,000. He was very anemic. There was an abscess pointing in the episternal notch. Signs of pericarditis were present. The liver and spleen were enlarged. The right great toe was swollen and red. There was tenderness to palpation about the right hip but all motions were free and without discomfort. The mediastinal abscess was drained; he was transfused but failed to improve. He died on the sixteenth day after onset. The diagnosis of osteomyelitis of the ilium was not suspected during life. At post mortem, the oldest lesion found was an acute osteomyelitis of the ilium with a large abscess in the iliac fossa.

CASE 2. S.G. S.M.H. No 51145, Italian boy of 5 years was admitted to the Strong Memorial Hospital August 30, 1931. His complaint was pain in the right hip. Five days before entry the patient fell while playing. He struck on the right hip and complained immediately of pain in that region. He limped around the rest of that day but that evening felt feverish and refused to eat. For 4 days following injury he did not walk because of steadily increasing pain in the hip. He continued to feel feverish.

Physical examination showed a thin boy of 5 who was apprehensive and irritable. He was acutely ill. Temperature was 40.6 degrees C, pulse, 130, respiration, 30. The skin was warm and flushed. The tonsils were large and somewhat injected. The lungs were clear. The heart was normal except for a soft apical systolic murmur. The abdomen was distended and tympanitic. Rectal examination was negative.

The patient refused to move the right lower extremity because of pain in the hip. There was a suggestion of fullness above the greater trochanter but there was no redness or increased local heat. There was no hip flexion or abduction contracture present. There was marked tenderness on palpation about the region of the greater trochanter and superior to it. All motions of the hip were greatly limited by pain but the extended extremity could be rotated if this were done gently and slowly.

Laboratory examination revealed hemoglobin, 60 per cent; white blood cells, 15,500. The urine was slightly cloudy yellow; reaction acid; no albumin or sugar. Microscopic examination showed only a rare pus cell. Wassermann reaction was negative. Blood culture on entry was positive for hemolytic *Staphylococcus aureus*. X-rays on entry were normal in appearance (Fig. 1).

On the day of entry the right hip joint was opened through a posterior Ober incision. When the joint capsule was opened there was an escape of 20 to 30 cubic centimeters of seropurulent fluid. A culture of this fluid grew hemolytic *Staphylococcus aureus*. Rubber drains were inserted down to the capsule and wound left wide open for drainage. Extremity placed in traction with hip slightly flexed.

The boy remained desperately ill for 10 days. The temperature remained around 40 degrees C., he was drowsy and at times irrational. He was sustained by direct blood transfusions, intravenous glucose, and fluid by hypodermoclysis.

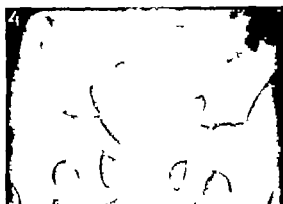
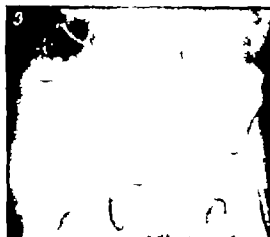
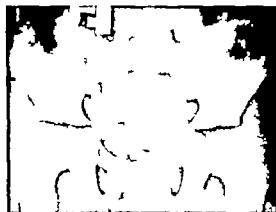


Fig. 1. Case 2. Normal appearance of right ilium and hip joint to onset.

Fig. 2. Case 2. Extreme destruction of right ilium month after onset.

Fig. 3. Case 2. Appearance of right ilium following partial resection 1/2 months after onset.

Fig. 4. Case 2. Two years after onset showing regeneration of ilium except for one small area, moderate upward and inward displacement of the acetabulum. The roof of the acetabulum is roughened. With this exception, the hip joint appears normal.

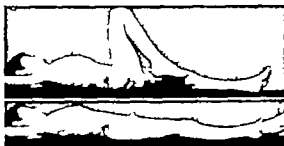


Fig. 5. Case 2. Patient 3 years after onset showing normal flexion and extension of hip. All other motions of the hip are equally normal. Wounds healed completely without scars.

At the end of this time the temperature came down to normal quite rapidly and the patient's general condition improved remarkably. He seemed well on the way to recovery. One month after entry the operative wound had completely healed and there was practically a normal range of motion in the hip joint. X-rays were taken at this time to determine the condition of the joint. They revealed an extensive osteomyelitis of the right ilium, the joint did not appear to be damaged. Previous to the taking of these X-rays, osteomyelitis of the ilium had not at all been suspected (Fig. 3).

A few days later partial resection of the ilium was done. An anterior Smith-Petersen incision was used. The origin of the muscles from the crest of the ilium was cut loose and the flap turned down subperiosteally. The greater portion of the wing of the ilium was found to be rough and honey-combed. The bone was quite soft and could be easily removed with a curette. The central portion of the wing was removed in its entirety and considerable necrotic granulation tissue was found on the pelvic side. The superior rim of the acetabulum and the periphery of the ilium were left

intact (Fig. 3) The wound was packed with vaseline gauze, the extremity was placed in traction with the hip flexed slightly. Culture from the ilium grew *Staphylococcus aureus*. Microscopical sections of the removed bone showed a subacute osteomyelitis. Convalescence following this procedure was long but steadily uphill. The wound continued to drain moderately. Five months after partial resection of the ilium an abscess accumulated under the gluteal muscles and had to be drained. The patient was followed with X-rays at frequent intervals and the ilium was seen gradually to regenerate. He was discharged 7 months after entry to a convalescent home for care. On discharge there was still a small draining sinus from the ilium.

Fourteen months after onset of his illness the boy was walking with crutches. The right lower extremity was 1 centimeter shorter than the left. X rays showed complete regeneration of the ilium except for one small area. The acetabulum was somewhat roughened and displaced slightly upward and inward changing the contour of the pelvic cavity (Fig. 4). There was still a small draining sinus. Two years after onset of the illness he was walking normally except for a very slight limp. The sinus has healed. There is a normal range of motion in the hip joint (Fig. 5).

The second case occurred in a boy of 5. He had fallen on his right hip and following this complained of pain in the hip and inability to walk. The following points were noted in the examination 5 days after onset. He was acutely ill, temperature 40.6 degrees C., white blood cells 12,500. There was marked tenderness about the right hip joint. All motions of the hip were limited and painful but the extended limb could be rotated if this were done slowly and gently. The diagnosis of pyogenic infection in the hip joint was made and confirmed by drainage. One month later X ray films showed extensive destruction of the right ilium. The affected portion of the ilium was resected. One year later the ilium had regenerated. Two years after onset, the right lower extremity is 1 centimeter shorter than the left due to upward displacement of the acetabulum. The boy is walking normally except for a very slight limp. There is normal range of motion in the hip joint all sinuses have healed.

CASE 3. H.S. S.M.H. No 66232 white boy of 14 years, entered Strong Memorial Hospital October 5, 1935. He had pain in the left hip. Two days before entry the patient had awakened with slight pain in the left hip. He went to school. The pain became worse and he began to have headache. He was sent home by the teacher. That afternoon he had a severe chill and went to bed. The rest of the day he felt alternately hot and chilly and the pain in the hip became more severe. The next day he remained in bed most of the time. He attempted to get up but was able to walk only a few steps. There was a little more pain in the left hip and thigh. He had another severe chill about noon. The pain in the hip, headache, fever and chills continued. He was brought to the hospital on the third day of his illness. Patient had had a running ear 2 years previously otherwise the past history was non-contributory.

Physical examination revealed an acutely ill appearing boy with temperature 40 degrees C. pulse, 120 respiration 25. The face was flushed and hot. The lungs were clear.

The heart was normal. The abdomen was soft and no tenderness or masses were made out. Rectal examination was negative except for moderate tenderness on the left side on pressure on the bony wall of the pelvis. The left hip was held slightly flexed. There was no pain on flexion or extension of the hip. The extended extremity could be passively rotated freely and without discomfort. There was pain on abduction of the hip. There was diffuse tenderness about the hip joint and pelvis on the left. This was most marked over the superior ramus of the pubis.

Laboratory examination revealed hemoglobin 95 per cent. red blood cells, 5,700,000 white blood cells, 15,600 polymorphonuclears, 75 per cent. The urine was clear amber reaction acid specific gravity 1.015 no albumin or sugar. Microscopic examination showed only an occasional epithelial cell. X ray films on admission were normal (Fig. 6).

Three observers thought the boy probably had an osteomyelitis of the pubis. A senior member of the staff interpreted the signs as being those of an early suppurative process in the left hip and advised drainage of the joint.

On the day of admission the left hip joint was opened by anterior approach. The joint appeared perfectly normal. There was no excess fluid. The synovium was not inflamed no flecks of fibrin were noted. A culture was taken from the surface of the head and neck of the femur and the wound was closed without drainage.

The boy continued to run a high septic fever ranging between 38.5 and 40 degrees C. he remained acutely ill. On the second postoperative day a flexion and abduction contracture of the hip began to develop. He was placed in traction in the line of deformity to overcome this. On this day he was seen in consultation with Dr. J. J. Morton, chief of surgery who said he suspected that the boy had an acute osteomyelitis of the ilium.

On the fifth day after operation, the wound was red, indurated, and tender and on this day culture which had been taken from the hip joint at operation showed a growth of hemolytic *Staphylococcus aureus*. The white blood count was 18,300. Blood culture which had been taken on entry also showed a growth of *Staphylococcus aureus* at this time.

It was felt that the boy's illness was probably due to a pyogenic infection in the left hip joint, which the operator had been unable to recognize at the original exploration because of the short duration of the infection.

Accordingly the wound was reopened under gas oxygen anesthesia. On separating the subcutaneous tissues 10 to 15 cubic centimeters of thick pus escaped, which culture later showed to contain hemolytic *Staphylococcus aureus*. The joint was opened and drains inserted down to the capsule. The wound was left wide open for drainage.

Following this procedure the patient was much improved. He became brighter and more alert. The temperature dropped from previous high level but remained definitely septic in type ranging between 37 and 38.5 degrees C. daily. X ray films on the twenty first day of illness showed definite osteomyelitis of the left ilium (Fig. 7). On looking back over X ray films taken on the seventh and tenth days after onset, it was noted that the beginning abnormalities in the X ray pictures could, without question be seen as early as the tenth day after onset.

At this time the patient was no longer dangerously ill although he was having daily rise of temperature to 38.5 degrees C. There was no tenderness over pubis or ilium. The wound into the hip joint was still draining slightly. The white blood cell count was 12,000.

One month after onset of the illness the wound into the hip joint had completely healed and there was normal range of motion in the joint. X ray films at this time showed that





Fig. 6. Case 3. Normal appearance of left ilium and hip joint at onset.

Fig. 7. Case 3. Moderate destruction of the left ilium 3 weeks after onset. The process involves the roof of the acetabulum and extends upward to the anterior superior spine.



Fig. 8. Case 3. Appearance of left ilium following partial resection 1 month after onset.

Fig. 9. Case 3. Appearance of the ilium 9 months after onset. There has been complete regeneration of the portion removed. The hip joint has been moderately involved as is shown by the narrowing of the joint space.



Fig. 10. Case 3. Patient 9 months after onset. Flexion and all other motions of the hip limited about 10 per cent. Wounds completely healed. No sinuses present.

there was a progression of the destructive process in the iliac bone. Because of this it was thought wise to resect the diseased portion of the ilium.

An incision was made from the greater trochanter up to the anterior superior spine of the ilium and curving back ward along the iliac crest. The origin of the gluteal muscles was cut loose from the crest and the ilium was exposed by reflecting them subperiosteally. The periosteum was thickened and osteomatous. The bone from the acetabular rim upward for a distance of about  $\frac{1}{4}$  inches was very soft and friable. It could very easily be removed with a curette. No free pus was found. The full thickness of the ilium was removed until the visceral periosteum was in view. All soft bone was removed until healthy bone was left (Fig. 8). The wound was left wide open—the muscle flap was packed back with large packs of vaseline gauze. Culture from this area showed *Staphylococcus aureus*. Sections of the bone revealed subacute osteomyelitis.

Following this procedure the patient gradually improved. The wound drained profusely at first but this gradually diminished until at the end of a month there was no evidence of a sinus. The temperature gradually became normal over the course of a month and a half.

Two months after resection of the ilium it was necessary to drain an abscess under the original incision into the hip joint. Culture of this proved it to be sterile.

The patient was discharged from the hospital 6½ months after entry. He was walking with crutches without bearing weight on the left side.

Nine months after the onset of his illness a ray examination showed that the affected area in the ilium had filled in with new bone. The joint space of the left hip was somewhat narrow and the acetabulum was displaced slightly inward (Fig. 9). The boy has a practically normal range of motion in the left hip joint, all motions being limited about 10 per cent. The wounds have completely healed without sinus formation (Fig. 10). He is still being made to walk with crutches without weight bearing on the affected side.

The third case was that of a boy 14 years old, who without antecedent trauma, began to complain of pain in the left hip. He had chills and fever and was unable to walk because of pain in the hip. Examination on the third day of his illness showed that he was acutely ill, temperature 40 degrees C., white blood cells 15 600. There was marked tenderness about the left hip, particularly over the pubis. All motions of the hip were free and without discomfort except for abduction. The hip joint was opened and found to be negative. Five days later it was necessary to reopen and drain the hip joint. X ray films 3 weeks after onset showed destruction of the left ilium. The affected portion of the ilium was resected. Nine months later the boy was walking with crutches. There was practically normal range of motion in the hip joint. The wounds have completely healed without sinuses.

#### DIAGNOSIS AND TREATMENT

The diagnosis of acute osteomyelitis of the ilium is by no means easy. This is, perhaps, partly because the physician fails to remember there is such a disease. On the other hand, the patient may present such a preponderance of constitutional symptoms that little attention is paid to the initial local complaint. This was true of the first case herein reported.

There is in a majority of patients a history of preceding trauma to the pelvis. The child complains for a few hours of pain in the hip and thigh following a fall. There is then an onset of malaise, fever and perhaps chills. The pain in the hip becomes progressively more severe and the patient is unable to bear weight on the affected side walking is impossible because of pain.

If the physician sees the patient at this stage of the illness he will, after obtaining a history similar

in most respects to the above note the following points on examination. The child will be acutely ill, the temperature will be elevated, there will be extreme tenderness to gentle palpation about the hip joint. (Bears says that the greatest point of tenderness is usually above and posterior to the greater trochanter.) On determining the range of motion in the hip joint he will be surprised to find that there is a much freer range of motion than he had expected and little in the way of muscle spasm.

After these findings the physician will probably be non-plused and the diagnosis as far as the family is concerned will be acute rheumatism, sciatica, sprain of the hip or some such condition but with a mental question mark on the physician's part. Heat will be applied to the hip and watchful waiting will be the course pursued.

At the end of about a week the physician will find that the patient is no better in fact, he will probably be considerably worse. He will still have high fever he may be irrational or even comatose. If he is so desperately ill that the constitutional symptoms completely obscure the initial complaint of pain in the hip the diagnosis will now be changed to meningitis, typhoid fever, generalized septicæmia (mistakes in diagnoses in fulminating cases frequently mentioned in the literature) or some other severe constitutional infection.

On the other hand if the child is still alert enough to respond to painful stimuli, it will be noted that the tenderness about the hip is definitely greater in severity and that now there is fairly marked spasm of the thigh muscles. All motions of the hip will be painful and limited, but if motions are carried out slowly and gently it will be found that free motion is present. This is especially true of rotation of the extended extremity, according to Holmes.

If at this point, the physician becomes alarmed and calls in a surgical consultant, the diagnosis will be cleared up at once. The surgeon will wonder how the physician could have been so stupid as to call this picture anything except a pyogenic infection in the hip joint. The patient will be taken to a hospital and the hip joint will be incised. At operation a small amount of seropurulent fluid will be found in the joint cavity and drainage will be instituted. Culture from this fluid will further substantiate the diagnosis by growing *Staphylococcus aureus*. Everybody's mind will be at ease.

The patient will now probably improve to a certain extent, but the surgeon will wonder why the fever continues to be septic in type. At the end of 3 or 4 weeks, X ray films will be taken to determine the condition of the hip joint, and much

to everyone's surprise, there will be a full-blown osteomyelitis of the ilium.

If the fates are kind and the surgical care is adequate the patient will be walking again in a year or two, possibly with a small draining sinus from the wound through which the dead bone of the ilium was removed.

We have told this story because it is typical of most of the cases reported in the literature and because the 3 cases reported here do not materially differ from it. In the first case the constitutional symptoms of a severe septicemia with numerous metastases so occupied attention that the diagnosis of acute osteomyelitis of the ilium was not made until postmortem. In the second case the child was first seen nearly a week after the onset of the disease and the signs pointed so strongly to the hip joint that it was opened and drained. The culture of the small amount of seropurulent material drained was positive for *Staphylococcus aureus* but osteomyelitis of the ilium was not suspected until the X-ray pictures revealed it a month later. The third boy was seen earlier on the third day after onset. But even though osteomyelitis of the pelvic bones (it is true, not of the ilium) was suspected and motion in the hip was free, still the hip joint was explored at the direction of a senior staff member and the diagnosis not made until 3 weeks later when the X-ray showed beginning destruction of the ilium.

Now why is this sequence of events of common occurrence? It is purely because of the anatomy of the ilium. The ilium is a flat bone as such it has a relatively thin cortex in comparison with long bones. It moreover has no medullary canal. In addition, in the young pelvis, the roof of the acetabulum is tripartate and thinly clad with cartilage. The pathology of infection in a flat bone is consequently different from that of a long bone.

There is, with the increase of tension inside the bone which accompanies the inflammatory process, an early perforation of the cortex which does not occur until late in long bone osteomyelitis. These perforations of the cortex produce the so called "mottled or moth-eaten" appearance in the X-ray negatives, characteristic of flat bone osteomyelitis.

In the ilium these perforations may occur anywhere but predominantly in one of three places: the internal iliac fossa, the external iliac fossa, or through the acetabulum into the hip joint. In children, because of the anatomy the disease invades the acetabulum early. In adults, an abscess forms more often under the iliacus muscle in the internal fossa or under the gluteal muscles in the external fossa.

It is, therefore, easy to understand why in children real spasm of the hip muscles with limitation of motion is found if the patient is seen late in the course of the disease.

From the natural history of the disease and an understanding of the pathological changes incident to infection in flat bones, a few points can be drawn which we believe may be of aid in diagnosis and treatment.

If a child complains of pain in the region of the hip following a trauma to the region, and on examination is found to be acutely ill with high fever, leucocytosis, tenderness, and increased local heat about the hip, but relatively free motion of the hip joint, then osteomyelitis of the ilium should be suspected. This, we believe, is so because (1) The pain of infection in the hip joint is often, although not always, referred to the knee. In osteomyelitis of the ilium, the pain is always about the hip with oftentimes inability on the part of the patient to localize definitely the site of discomfort. In none of the cases reported nor in our cases has pain been referred to the knee. (2) Flexion and abduction contracture occurs very early in septic involvement of the hip joint. In osteomyelitis of the ilium no contractures are present until later. (3) Pyogenic infection in the hip joint manifests itself early by almost complete fixation of the hip joint due to muscle spasm, in osteomyelitis of the ilium in the first few days of the disease, motion in the hip is free. (4) If osteomyelitis of the pelvic bones is suspected then the ilium is the bone by far the most likely to be affected. Acute osteomyelitis of the pubis and of the ischium is so rare that it is hardly necessary to give it consideration.

If the diagnosis is made, then what should be the treatment? Scott believes that "palpable masses in and outside the pelvis are watched for and surgical drainage promptly done if they are found. The construction of the iliac bone predisposes to rupture to the visceral side and, therefore, it is to this side that we may expect to locate the pocketing of escaped pus rather than to the outer side. No radical surgery has seemed necessary and apparently the less radical surgery done the better for the patient. We would like to discourage radical procedures as we believe them not to be needed. The true osteomyelitis seems rather a self-limited problem in the pelvis and yields readily to proper drainage." Short states "it seems better in the acute stage to drain down to the bone, but not into it, as pus has not yet formed opening up the cancellous bone predisposes to septicemia by opening up the veins in the cancellous spaces to infection."

Skilern says in a case reported in 1917 "It was thought that trephining the bone would not only evacuate the iliac abscess but also open up the spaces in the cancellous bone of the dorsum of the ilium just as in the mastoid operation." We believe this to be very rational treatment for the following reasons.

By far the most frequent complication of osteomyelitis of the ilium mentioned in the literature, and we agree, is invasion and destruction of the hip joint. If this be so then it seems that treatment should be directed toward saving the patient's life, and secondly preventing destruction of the hip joint. Most of these patients have a blood stream infection from the beginning all 3 of our patients had positive blood cultures of *Staphylococcus aureus*. Free drainage and decompression, we believe, should then be established as soon as possible. It is true that perforation takes place early which drains the infected bone, but if we can surgically produce this perforation earlier we have done three things (1) we have decompressed the cancellous bone which is the focus for the septicemia, (2) we have attempted to prevent spontaneous perforation with abscess formation on the visceral side of the ilium which is more difficult to handle, and (3) we have attempted to prevent invasion of the hip joint.

We, therefore, think that if the diagnosis can be made early that the gluteal muscles should be reflected superiosteally from the ilium after the manner of Smith Petersen and the bone drilled until pus is found. In this area the cortex should be removed. By so doing an outlet will be allowed for the infection locked in between the two cortical layers. Adequate external drainage will prevent spontaneous perforation through the visceral cortex and downward spread through the acetabulum into the hip joint.

Following this the extremity should be kept in traction with the hip abducted and slightly flexed to prevent deformity of the acetabulum and possible dislocation of the hip. Even though this is diligently carried out, mild deformity of the acetabulum occurs as is shown in Figures 4 and 9. This occurs due to the upward pull of the hip muscles forcing the head of the femur upward and inward into the softened ilium.

If, of course, the patient presents himself late with abscesses already formed in the internal or external iliac fossae these should be drained as Scott suggests, but we do not believe it is wise to wait for them to form. Internal iliac fossa abscesses should be drained externally by trephining through the ilium. They can be drained extra peritoneally above the inguinal ligament but this

does not afford as adequate drainage as entering the bottom of the abscess through the ilium, nor is it as safe because of the danger of introducing the infection into the peritoneal cavity. If there are true signs of hip joint involvement, then the joint must be drained. As to resection of the affected portion of the ilium, we agree with Monsaingeon, Barse, von Bergmann, and others that this depends upon the extent of the bone involved. If there is much dead bone later in the course of the disease, then this must be removed.

The convalescence is long and oftentimes complicated by recurring abscesses. The patient should be protected from bearing weight on the affected side until there is evidence by X ray that the ilium has fully regenerated and the hip joint is as normal as one thinks it will become.

The prognosis in acute osteomyelitis of the ilium as regards life is more grave than in the more common form of acute osteomyelitis of the long bones. In Krasnobajiv's series of cases, referred to above the general mortality was 22.4 per cent while in the 20 cases of acute osteomyelitis of the ilium the mortality was 40 per cent. Of Buosanti's 4 cases 3 succumbed. Kolouch states that "the picture is often one of an intense and rapidly fatal sepsis in the face of which surgery finds itself quite helpless."

Besides being more dangerous as regards life, the disease is also quite disabling if the patient survives. This is not only due to the sinuses and recurrent abscesses common to all osteomyelitis but also to the frequent involvement of the hip joint resulting in painful limited motion and at times, complete ankylosis.

#### SUMMARY

1. The frequency of acute osteomyelitis of the ilium is about 5 per cent of all osteomyelitis. It is the most frequently affected flat bone, comprising 20 per cent of all flat bone osteomyelitis.

2. Three cases of acute osteomyelitis of the ilium are reported in detail.

3. The difficulties in diagnosis are pointed out, particularly with regard to the differential diagnosis between acute osteomyelitis of the ilium and acute pyogenic infection of the hip joint.

4. In acute osteomyelitis of the ilium there is, early in the disease free motion in the hip where as in acute pyogenic infection of the hip joint, motion is practically absent due to muscle spasm. The reference of pain is also usually different in the two conditions. Flexion and abduction contraction of the hip occur early in pyogenic infection of the hip joint much later in acute osteomyelitis of the ilium.

5 The anatomy of the ilium in children predisposes to early invasion of the hip joint. Spontaneous perforation of the cortex occurs early. In adults perforation to the visceral side of the ilium is most common.

6 Treatment early in the disease consists in removing the outer layer of cortex in the infected area. This insures drainage of the cancellous bone and is an attempt to prevent spread of the disease into the hip joint.

7 The prognosis is more grave than in acute osteomyelitis of the long bones.

## BIBLIOGRAPHY

- 1 BEARNE, CARL. Osteomyelitis of the ilium in children. Boston M. & S. J., 1914, cxc, 885-886.
- 2 BEARNE, C. Osteomyelitis of the ilium in children. J. Am. M. Ass., 1923, lxxx, 991-992.
- 3 BOGART, L. M. Résumé and general consideration of osteomyelitis of hematogenous origin. J. Mich. Med. Soc., 1923, xxii, 503-507.
- 4 BROMANTI, P. L'Osteomielite acuta dell'ileo nell'infanzia. Arch. ital. di chir., 1924, x, 1-45. Abstracted in J. Am. M. Ass. 1924, lxxxiii, 544.
- 5 FLICKINGER, W. G. Osteomyelitis of ilium: report of case. Long Island M. J. 1927, xii, 95-97.
- 6 FRACROCK, E. Beiträge zur Kenntnis der akuten spontanen Osteomyelitis der kranken und platten Knochen. Beitr. z. klin. Chir. 1889, v, 70-100.
- 7 GRIST, EMM. S. Osteomyelitis of the pelvic bones. J. Am. M. Ass. 1921, lxxvii, 1930.
- 8 HOLMES, A. H. Acute osteo of ilium. Brit. M. J. 1931, ii, 533.
- 9 JONES, E. Osteomyelitis of ilium. Illinois M. J. 1931, lxxv, 77-78.
- 10 KOLCHERIKI, K. D. Ostrovy vospaleniya kostnava mozga, podvzoshnoi kosti (Acute Osteo. of ilium). Voprano-Med. J. S. Petersb. 1901, lxxiv, 710-730.
- 11 KOLDOVSKY, F. G. Osteomyelitis of the ilium. Nebraska M. J. 1924, ix, 104-106.
- 12 KRASNOBRY, Novyj chirurg. arch. 1915, v, 354.
- 13 LEWALD, L. T. Perforative osteomyelitis of the iliac bone. Am. Atlas Stereocentgenol. 1917, ii, 60.
- 14 MAXIMOW, A. Contributo allo studio delle osteomieliti dell'osso ileo. Ann. di Ippocrate, Milano, 1908-1909, li, 309-337, 421-477.
- 15 MAMAROU, GUILL., and LAUX. Osteomyelitis de la fosse iliaque interne par l'ita, l'union pathologique de la hanche. Bull. Soc. d. sc. méd. et biol. de Montpellier 1925-1926, vii, 159-163.
- 16 MAUDRY, M. Osteomyelitis de l'os iliaque fracture spontanée de la cavité cotyloïde, mort par septicémie. Bull. Soc. Anat. de Par. 890, lxxv, 508-510.
- 17 MONTAGNON, MAURICE. De L'Osteomyelitis aigue de l'os iliaque. Thèse de doct. Paris, 1911.
- 18 MURPHY, J. B. Osteomyelitis of ilium, treatment by antiserumized autogenous vaccine. Surg. Clin. vol. v, 751. Philadelphia W. B. Saunders Co. 1915.
- 19 NOVE, JOSEPH. Osteomyelitis du bassin; ablation de l'ilium régénération complète de l'os. Lyon méd. 1905, clv, 534-536.
- 20 OLSZANSKI, A. Przyczynek do rozpoznania i leczenia zapalen w linii przystawkowej pancerz bladowej. (Contribution to diagnosis and treatment of acute osteomyelitis of the ilium.) Gaz lek. Warszawa, 1895, xv, 1-8.
- 21 PAOLICCI, F. Acute osteomyelitis of marginal crest and anterior inferior spine iliac; case. Minerva med. 1931, i, 546-549.
- 22 PASQUER, F. Contribution à l'étude clinique de l'ostéomyélite de l'os iliaque. Thèse de doct., Paris, 1900.
- 23 PIERREMAIS, G. L'Osteomyélite de l'ilium dans l'enfance. Arch. franco-belges de chir., 1923, xxvi, 970-977.
- 24 PETIT, M. Osteomyélite de l'os iliaque. Bull. Soc. Anat. de Par. 893, lxxvii, 215-222.
- 25 RENDU, A. Ostéite de l'ilium chez l'enfant. Paris méd. 1927, lxxv, 66-70.
- 26 ROBERTSON, R. C. Primary osteomyelitis (chronic fibrous) of anterior superior spine of ilium case. South M. J. 1932, xiv, 825-828.
- 27 ROYDA, F. Osteomyelitis of ilium in children. Gazz. med. lomb., 1927, lxxvii, 9-3.
- 28 SCOTT, E. LAURENCE. Osteomyelitis of the pelvis. South M. J. 1927, xx, 104-107.
- 29 RYAN, C. A., and FURSTON, R. V. Osteomyelitis of ilium case (probably tuberculous). J. Bone & Joint Surg. 1910, xii, 165-167.
- 30 SARTY, A. R. Acute osteomyelitis of ilium. Brit. M. J. 1931, ii, 97-98.
- 31 SHROVER, C. C. The treatment of osteomyelitis. Surg. Gynec. & Obst., 1915, xx, 129-133.
- 32 SULLIVAN, P. G. Acute pyogenic osteomyelitis of ilium with iliac fossa abscess, trephine of ilium recovery. Internat. Clin. 1917, 27th series, iv, 191-193.
- 33 THOMSEN, Ueber akute osteomyelitis des Schambeins. Deutsche Zeitschr. f. Chir. 1913, cxviii, 300-304.
- 34 VON BERGMANN, A. Erfahrungen ueber Beckenosteomyelitis. Arch. f. klin. Chir. 1906, lxxxi, 504-59.

## A STUDY OF THE VENTRICULOGrams IN NINETY-SEVEN CASES OF VERIFIED INTRACRANIAL TUMORS

COBB PILCHER<sup>1</sup> M.D., NASHVILLE, TENNESSEE  
Assistant Professor of Surgery Vanderbilt University School of Medicine

HUGH M. WILSON M.D. ST. LOUIS, MISSOURI

DEB. WOODRICK

Department of Radiology Washington University School of Medicine and the Edward Mallinckrodt Institute of Radiology

THE diagnostic value of pneumoventriculograms is dependent upon the surgical and roentgenological technique employed and particularly upon careful interpretation of the findings. This fact has been repeatedly emphasized by Dandy (4, 5, 6) since his introduction of the procedure in 1918.

The deceptive findings due to insufficient filling of the ventricular system with air, or to other technical errors are well known to those familiar with this method of examination. The present study was undertaken to determine and evaluate the more or less constant and dependable criteria by which localization of intracranial lesions may be determined from ventriculograms. For this purpose only cases in which the lesions had been verified at operation or autopsy were studied. All cases in which the roentgenograms were technically unsatisfactory were frankly discarded. From a total of 390 'tumor suspects' upon whom pneumoventriculograms have been made in this clinic, 97 cases of verified intracranial lesions were selected as being entirely suitable for a critical study. There were a few other cases upon whom ventriculograms were made and in whom at operation lesions were found, but either no tumor tissue was removed or the lesion was not space occupying or for some other reason the findings did not seem to warrant the inclusion of the case in this study. This study, then, should afford a true exposition of the ventriculographic abnormalities

resulting from lesions in various locations in the cranial cavity

## TECHNIQUE

In most instances, the air was injected into the occipital horn of one ventricle with the patient in the sitting or semirecumbent position in the manner recently described by Davis (8). In a few cases the ventricle needle was introduced through the frontal lobe. A blunt ventricle needle graduated in centimeters and equipped with a three way stop-cock into which a 10 cubic centimeter syringe fits was used (14). Air was injected into only one side that opposite the suspected lesion. If it was impossible to obtain fluid from the ventricle first tried, the needle was then introduced into the opposite ventricle. By introducing air into only one side one is sometimes able to determine the patency of the interventricular foramina (of Munro) by passage of the air from one ventricle to the other. As much cerebrospinal fluid as possible was replaced by a slightly smaller volume of air except in cases showing marked ventricular dilatation. In these instances, the amount of air injected varied from 40 cubic centimeters to 150 cubic centimeters and it was always allowed to escape after the completion of the roentgenographic series, unless exploratory operation were to follow immediately.

After injection of the air and closure of the wound, the patient was taken to the X-ray laboratory. In all pneumoventriculograms a flat head

TABLE I

Site	Contralateral displacement		Localizing definiteness of displacement	Dilatation		Diagnostic value				No. of cases
	Lateral ventricle	Third ventricle		Lateral ventricle	Lateral and 3rd ventricle	Laterallizing	Localizing	Indeterminate	Misleading	
Frontal	16	16	16			6	16	3	1	36
Parietal	6	6	9			1	9		1	1
Temporal	14	13	4			10	4	0	2	16
Supratentorial			3	8	0		4	1	0	3
Intral region			3	0	3		9	1		
Posterior fossa				3	30		20	1	3	24

TABLE II.—FRONTAL LESIONS

Case	Site	Lesion	Lateral ventricle	Third ventricle	Locating value
U 7133	Right frontal	Abscess	Collapse of left. Right displaced to left	Displaced to left	Positive Lateralizing
U 9737	Right frontal	Asterioma	Pressure deformity of tip of right anterior horn	Normal	Positive Localizing
3 U 1498	Right frontal	Abscess	Right displaced to left. Collapse of right anterior horn	Displaced to left	Positive Localizing
4 U 15340	Right frontal	Asterioma	Partial collapse, right anterior horn. Both ventricles displaced to left	Displaced to left	Positive Localizing
5 U 16634	Left frontal	Metastatic carcinoma	Collapse of left anterior horn. Both ventricles displaced to left	Displaced to right	Positive Localizing
6 U 16681	Right frontal	Meningeal fibroblastoma	Collapse of right. Left displaced to left	Displaced to left	Positive Localizing
7 U 16716	Left frontal	Meningeal fibroblastoma	Pressure deformity of left anterior horn, which is displaced posteriorly. Both ventricles displaced to right	Displaced to right	Positive Localizing
8 U 17073	Corpus callosum and right frontal	Spongioblastoma multiforme	Right anterior horn and body compressed downward	Displaced to left	Positive Localizing
9 U 18011	Left parietotemporo-frontal	Huge abscess	Partial collapse and pressure deformity of left. Both displaced to right	Displaced to right	Positive Localizing
11 U 18596	Left frontal	Meningeal fibroblastoma	Pressure deformity and posterior displacement of left anterior horn. Both ventricles displaced to right	Displaced to right	Positive Localizing
12 U 19494	Left frontal	Small organized astrocytoma	Normal	Normal	Misleading
U 2063	Right parietofrontal	Metastatic carcinoma	Collapse of right. Pressure deformity of left. Displacement of both to left and downward	Very faint. Displaced to left	Positive Lateralizing
13 U 2155	Within anterior horn of right lateral ventricle	Mechano-blastoma	Tumor shadow visualized as air filled right ventricle	Displaced posteriorly	Positive Localizing
14 U 7239	Right frontal	Spongioblastoma multiforme	Right anterior horn displaced downward	Displaced to left	Positive Localizing
15 U 77233	Left parietofrontal	Asterioma	Left collapsed. Right dilated	Displaced to right	Positive Lateralizing
16 U 9383	Middle frontal	Meningeal fibroblastoma	Partly filled. Right anterior horn displaced to right	Not visualized	Indeterminate
17 U 33564	Right frontal	Meningeal fibroblastoma	Collapse of right anterior horn. Left anterior horn displaced downward. Both displaced to left	Displaced to left	Positive Localizing
18 U 43636	Left frontal	Asterioma, left middle cerebral artery	Collapse of left anterior horn. Deformity medial border of right, which is dilated and displaced to left	Normal	Positive Localizing
9 U 554	Tip of right frontal lobe	Abscess	Incompletely filled, apparently normal	Not visualized	Indeterminate
20 U 5857	Left frontal	Spongioblastoma multiforme	Collapse of left anterior horn with posterior displacement of body. Left dilated	Normal	Positive Localizing
21 U 77300	Right frontal	Chondrosarcoma	Partly filled. Right less filled than left. No deformity	Not visualized	Indeterminate
22 U 34693	Right frontal	Meningeal fibroblastoma	Left not visualized. Right displaced to left. Deformity of right anterior horn	Questionably visualized in midline	Positive Localizing
23 U 1360	Right frontal	Tuberculoma	Pressure deformity of right anterior horn	Normal	Positive Localizing
24 U 16411	Left frontal	Spongioblastoma multiforme	Both displaced to right	Displaced to right	Positive Lateralizing
25 U 16411	Right frontal	Asterioma	Displacement of both to left, especially right anterior horn	Displaced to left	Positive Localizing
26 U 16411	Left frontal	Spongioblastoma multiforme	Collapse of left. Right displaced to right	Displaced to right	Positive Lateralizing

\*The authors are aware of the rarity of such Rohrbach's in the cerebral hemisphere as well as of spongioblastoma multiforme in the cerebellum (Case 9, Table VII). However, the location is both of these cases have been re-examined and the diagnoses are believed to be correct.

TABLE III.—PARIETAL LESIONS

Case	Site	Lesion	Lateral ventricles	Third ventricle	Localizing value
27 U19918	Left parietal extending in to body of ventricle	Hemangioblastoma	Filling defect of body of left lateral. Both displaced to right	Dislocated to right	Positive Localizing
28 U13127	Right frontoparietal	Spongioblastoma multiforme	Right anterior horn and body not visualized. Both displaced to left	Dislocated to left	Positive Localizing
29 U30037	Right parietal	Astrocytoma	Right anterior horn not seen. Right body shows pressure deformity. Both ventricles displaced to left	Dislocated to left	Positive Localizing
30 U13312	Right parietal	Huge cyst. Sections of wall show only gliosis	Deformity of body of right. Both displaced to left	Dislocated to left	Positive Localizing
31 U17966	Right cerebral	Subdural hematoma covering hemisphere	Right lateral not seen in P.A. views, but visualized in a third	Not visualized	Indeterminate
32 U13341	Left parietal	Small astroblastoma between body and in lesser horn	Normal	Normal	Misleading
33 U3119	Right parietal	Spongioblastoma multiforme	Pressure deformity of roof of right body. No displacement	Normal	Positive Localizing
34 S17828	Right parietal	Astrocytoma	Deformity of right anterior horn and body. No displacement	Normal	Positive Localizing
35 U14452	Right occipitoparietal	Spongioblastoma multiforme	Body and posterior horn of right depressed	Normal	Positive Localizing
36 S1786	Right parietal	Sarcoma	Collapse of right. Left displaced to left	Dislocated to left	Positive Lateralizing
37 U19311	Left frontoparietal	Meningeal fibroblastoma	Collapse of body of left and pressure deformity of body of right. Right displaced to right	Dislocated to right	Positive Localizing
38 B180	Left parietal	Spongioblastoma multiforme	Collapse of body of left with pressure deformity of its posterior portion	Normal	Positive Localizing

## RESULTS

Ninety-seven cases were studied. Of these 26 were frontal lobe lesions, 12 parietal, 16 temporal, 5 suprasellar, 12 in the pineal region, and 26 lay in the posterior fossa (Table I). Such localizations, of course, are not strictly accurate since large tumors in any of the lobes of the cerebral hemispheres are likely to extend into or impinge upon portions of adjacent lobes. Thus, although none of the tumors in this series of cases is classified as 'occipital, several of the 'parietal' and

'temporal' tumors involved the occipital lobes as well.

In each case the region specified herein is that in which the greater portion of the lesion was located. The cases are classified as 'positive,' 'indeterminate,' or 'misleading' on the basis of interpretation of ventriculograms alone, without consideration of clinical findings. By 'positive,' it is meant that the approximate location of the lesion could be definitely determined from examination of the films alone. The positive cases in the cerebral hemispheres are further subdivided into 'lateralizing' and 'localizing' groups according to whether the hemisphere or the parietal lobe involved could be determined. The classification 'indeterminate' is applied to those cases in which the findings were abnormal, but the location was not definitely indicated. Under "misleading" are placed those cases in which the ventriculographic findings indicated an incorrect location of the lesion or in which normal ventricular outlines were found, even though a space occupying lesion was subsequently proved to exist.

The various cases will be considered in groups,



TABLE IV—TEMPORAL LESIONS

Case	Site	Lesion	Lateral ventricle	Third ventricle	Localizing value
99 U 34944	Left occipital	Sarcoma	Pressure deformations of left inferior and posterior horns. Both ventricles displaced to right	Displaced to right	Positive Localizing
99 L 4455	Left frontotemporal	Thick anastomosed cyst	Left inferior horn not visualized. Both ventricles displaced to right	Displaced to right	Positive Localizing
4 S 17304	Left temporal	Spongioblastoma multiforme	Both displaced to right. Incompletely filled in lateral view	Not visualized	Positive Localizing
47 U 33778	Right occipital	Spongioblastoma multiforme	Both dilated. Both displaced to left, somewhat laterally	Displaced to left	Positive Localizing
43 U 4456	Left temporal	Spongioblastoma multiforme	Left inferior horn not visualized. Right dilated. Both displaced to right	Displaced to right	Positive Localizing
44 S 17584	Right temporal	Astroblastoma	Right inferior horn not visualized. Both displaced to left	Displaced to left	Positive Localizing
43 U 3451	Right parietotemporal	Astrocytoma	Both incompletely filled but displaced to left	Displaced to left	Positive Localizing
66 U 17613	Right temporal	Astrocytoma	Partial collapse of right. Both displaced to left	Displaced to left	Positive Localizing
4 U 34	Right temporal	Meningeal fibroblastoma	Both dilated, left more than right. Both displaced to left	Displaced to left	Positive Localizing
48 U 3469	Left temporal	Unusual anaplasia on cortical surface	Normal	Normal	Misleading
99 U 17345	Left temporal	Spongioblastoma multiforme	Both displaced to right, incompletely filled	Displaced to right	Positive Localizing
90 U 3503	Right temporal	Spongioblastoma multiforme	Right not visualized. Left dilated and displaced to left	Displaced to left	Positive Localizing
51 U 1919	Left temporal	Metastatic carcinoma	Left partially collapsed. Both displaced to right	Displaced to right	Positive Localizing
52 L 44	Left temporal	Oligodendroglioma	Left displaced to right. Right dilated	Not visualized	Positive Localizing
43 U 34718	Left frontotemporal	Ependymoma	Left not visualized. Right incompletely filled and displaced to right	Displaced to right	Positive Localizing
54 G 3714	Left temporal	Subdural hematoma	Normal	Normal	Misleading

TABLE V—SUPRASELLAR LESIONS

Case	Suprasellar calcification	Lesion	Lateral ventricle	Third ventricle	Localizing value
83 U 30440	Present	Craniohypophyseal pouch cyst	Both slightly dilated	Not visualized	Positive
58 S 6669	Absent	Craniohypophyseal pouch cyst	Both dilated	Very faintly visualized. Not dilated	Indeterminate
37 U 37740	Present	Craniohypophyseal pouch cyst, largely left sided	Both displaced to right. Deformities of left temporal and right anterior horns	Displaced to right	Positive
58 U 36715	Absent	Meningeal fibroblastoma	Deformities of floor of left anterior horn	Normal	Positive
39 U 36881	Absent	Meningeal fibroblastoma	Deformities of inferior medial borders of both anterior horns	Displaced posteriorly with deformity of anterior border	Positive

according to the location of the lesion.

1. *Frontal.* In this group of 26 cases, 12 are classified as positive, 3 as indeterminate, and 1 as misleading (Tables I and II). In the single mis-

leading case, normal ventricular relationships were found in a patient from whose left frontal lobe there was subsequently removed a small or ganized aneurysm. This measured less than 2

RT.



Fig. 1. Case 8. The anterior horn and adjacent portion of the body of the right lateral ventricle are compressed from above by a large frontal lobe tumor

centimeters in its greatest dimension and lay very close to the cortical surface. In this location it would not be expected to cause a ventricular deformity. Of the 22 positive cases the exact location could be determined in 16 and the hemisphere involved in the 6 remaining cases. Contralateral displacement of the lateral and third ventricles was found in 16 cases and localizing deformities or displacements in 16 cases. In one instance (Case 13) the outline of an intraventricular tumor was brought into relief by the air.

2. *Parietal* Of the 12 cases in this location (Table III), 9 showed localizing abnormalities, 1 could be only lateralized, 1 was indeterminate, and 1 misleading. In 6 cases there was displacement of the ventricular system to the side opposite the lesion and in 9 the locations were indicated by localizing deformities.

3. *Temporal* Of the 16 cases with temporal lobe lesions the ventriculograms of 14 were positive (Table IV). However only 4 of these showed localizing abnormalities, the remaining 10 indicating only the side of the lesion. The 2 additional cases were misleading both showing normal ventricular outlines in the presence of superficial extracortical, flat lesions in one instance (Case 48) a venous angioma, in the other (Case 54) a subdural hematoma. All 14 of the positive cases

RT

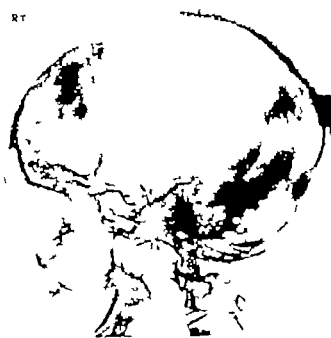


Fig. 2. Case 33. The body of the right lateral ventricle is deformed by a spongioblastoma multiforme of the right parietal region. The third ventricle is slightly displaced to the left.

showed displacement of the ventricular system. (In 2 of them the third ventricle was not visualized.)

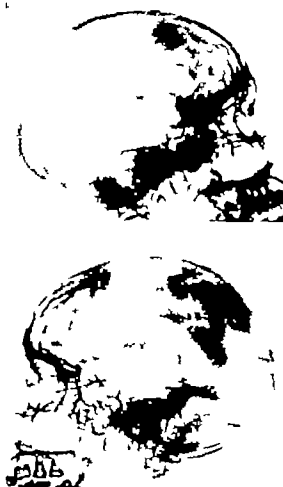


Fig. 3. Case 43. The ventricular system is displaced to the right, and the left inferior horn is collapsed by a large left temporal lobe tumor. The right lateral ventricle is dilated.

4 *Suprasellar* In 3 of the suprasellar cases (Table VI) definite localizing deformities were present. A fourth is classified as positive on account of the presence of dilated lateral ventricles, obliterated third ventricle and suprasellar calcification. A fifth case (Case 56) showed dilated lateral ventricles, a small, very faint third ventricle but no calcification. It is listed as indeterminate.

5 *Pineal region* In this category are included all lesions arising primarily in or near the midline immediately above the tentorium (Table VI). Of the 12 cases, 9 were positive, 2 misleading and 1 indeterminate. In the two misleading cases, the third ventricle, as well as both lateral ventricles was dilated but without deformity. In the indeterminate case only one of the lateral ventricles was visualized. Localizing deformities were present in 3 cases, in one of which (Case 64) the tumor shadow was visualized.

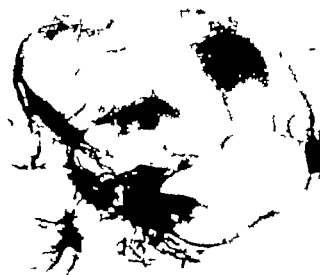
6 *Posterior fossa* Twenty of the 26 cases in this group were positive (Table VII). 4 are listed as misleading on account of failure to visualize the third ventricle and 1 because the entire series showed normal relationships (in a patient having a superficial plaque of metastatic carcinoma on the surface of one cerebellar hemisphere). The single remaining case was indeterminate because the third ventricle though visualized was not apparently dilated.

#### COMMENTS

Of the 97 ventriculograms reported only 18 failed to indicate the approximate location of the lesion. From the mass of possible anatomical deformities there are relatively few constant findings of diagnostic importance. In those cases with lesions in the cerebral hemispheres, displacement of the ventricular system, including the third ventricle, to the opposite side is the most reliable



Fig 4 Case 8 There is dilatation of the third and both lateral ventricles. This was produced by an astrocytoma obiterating the fourth ventricle. The cavum pellucidum is visualized.



past year we have taken lateral views of the two anterior horns filled with air as recommended by Naffziger

Parietal lobe lesions usually show displacement of the lateral ventricles and collapse or deformity of the body of the ventricle on the side of the lesion (Fig 2) whereas temporal lobe tumors almost invariably (14 cases out of 16) cause dislocation of the lateral ventricle and the third ventricle with no dependable localizing deformity. Accompanying the dislocation there is usually some flattening of the body of the homolateral ventricle. Failure to visualize the entire inferior horn is a common result of incomplete filling of the ventricular system with air and cannot be regarded as of localizing significance unless it is persistently unilateral or accompanied by definite pressure deformity (Fig 3). Even under these circumstances, it is often a deceptive finding and must be evaluated with great caution.

The posterior horns of the lateral ventricles have such a wide normal anatomical variation that in most cases no significance can be attached to apparent abnormalities observed in them. We have been unable to confirm the observation of

and valuable finding. Filling defects may be deceptive and are of greater significance when associated with ventricular displacement.

Deformities of the anterior horns or their displacement in a vertical plane are often of great value, but must be interpreted with caution. In this series the most common localizing deformities caused by frontal lobe lesions were collapse or posterior displacement of the tip of the anterior horn (Fig 1). It is for this reason that during the

RT



Fig. 5. Case 64. Both lateral ventricles and the anterior portion of the third ventricle are dilated. There is deformity of the body of the left ventricle produced by a tumor the outline of which is brought into relief by the intraventricular air. The tumor was a primitive glioma of the pineal region.

TABLE VI—PINEAL REGION

Case	Sex	Lesion	Lateral ventricles	Third ventricle	Locating sign
30 F 547	Female	Pilocystoma	Both dilated. No deformity	Not visualized	Positive
61 M	Male	Arachnoid cyst	Both dilated. No deformity	Not visualized	Positive
6 U 878	Female	Spongoblastoma polare	Both dilated. No deformity	Not visualized	Positive
6 U 144	Female	Teratoblastoma	Both dilated. Right anterior horn slightly deformed to left	Not visualized	Positive
U 466	Female	Neuroepithelioma	Both dilated. Body of right upward. Tumor visualized	Dilated, deformed to right. Pressure deformity of posterior border	Positive
5 U 1497	Female	Arachnoid cyst	Both dilated. Pressure deformity of posterior, inferior medial side	Pressure deformity of posterior border	Positive
66 U 369	Female	Cholesteatoma	Both dilated. No deformity	Not visualized	Positive
67 S 481	Female	Astroblastoma	Both dilated. No deformity	Not visualized	Positive
68 U 1175	Female	Spongoblastoma multicystic	Slightly dilated	Slightly dilated	Misleading
69 F 2036	Female	Pilocystoma	Only right lateral visualized and dilated	Not visualized	Indeterminate
70 U 1990	Female	Pilocystoma	Both dilated. No deformity	Dilated. No deformity	Misleading
71 U 409	Female	Pilocystoma	Both dilated. No deformity	Third part of 12 not dilated	Positive



Fig. 6. Case 55. The third ventricle is obliterated by a suprasellar cyst. Flocculent suprasellar calcification is seen (arrows).

Elberg and Silbert that unilateral lesions in the posterior fossa cause corresponding deformity or displacement of the overlying posterior horns. However outward and upward displacement with deformity of the inferior surfaces of the posterior horns does occur with large tumors in the pineal region (Fig. 4). Such abnormalities usually involve the bodies of the ventricles as well as the posterior horns. In suspected unilateral occipital lobe lesions, anteroposterior and lateral views with the occiput uppermost are of great value. Displacement is of greater significance than variation in size or shape.

In the absence of definite localizing abnormalities, the exact location of cerebral lesions cannot be determined by ventriculography alone. However, three additional facts brought out by this study are of some significance and when correlated with clinical evidence, may be of great value. First, temporal lobe lesions cause contralateral displacement of the system in a much higher proportion of cases (Table I) than do lesions elsewhere in the hemisphere (doubtless due to their position lateral to rather than above the ventricular system). Second parietal and to a slightly lesser extent, frontal lobe lesions cause localizing deformities much more frequently than do lesions in the temporal lobe. Third failure to visualize the ventricle on the side of the lesion (probably

due to obstruction of the foramen of Munro) occurs much more frequently with frontal lesions than with those elsewhere. 6 of 26 (23 per cent) frontal cases as opposed to 1 of 12 (8 per cent) parietal and 2 of 16 (12 per cent) temporal cases.

The classical ventriculographic picture of posterior fossa lesions is uniform, symmetrical dilatation of both lateral ventricles and of the third ventricle. This picture is borne out by most of the cases in this study. However in 5 cases the third ventricle was not visualized. Such misleading findings may lead to the dangerous misconception that the lesion lies above the tentorium with a resulting negative and often disastrous supratentorial exploration.

The converse difficulty is often encountered in patients with midline lesions lying immediately above the tentorium—tumors of the pineal region

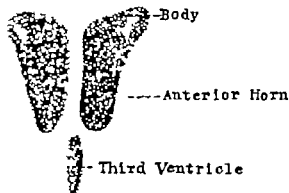


Fig. 7. Diagram of normal appearance of ventricles as seen in postero-anterior view.



Fig. 8. There is visualization of part of the body and anterior horn of the right lateral ventricle. Note that the butterfly wing (body) of the left ventricle is absent in the postero-anterior view. Only the anterior horn of the left ventricle is visualized as may be seen in the lateral view. Both films made without changing the position of the head. (This is a recent case not included in the present series.)

the corpora quadrigemina or the posterior portion of the third ventricle. Ventriculograms in patients with these lesions often show a uniform dilatation of the lateral ventricles and non-visualization of the third ventricle. However, in some cases the anterior portion of the third ventricle is dilated (Fig. 4). In all cases in which this question arises it is imperative to make every effort to determine which portion of the third ventricle is visualized. Of greatest value are lateral views with occiput and face dependent.

The importance of this difficulty is not universally recognized. Some authors seem to assume that the presence or absence of third ventricle visualization is proof that the lesion lies below or above the tentorium. Thus Grant in the legend of Figure 10 says, "Note that in subtentorial tumors, the third ventricle is clearly shown, whereas in supratentorial midline tumors, it is not clearly shown. Similarly Adson states, 'Lesions of the posterior fossa produce internal hydrocephalus, with dilatation of the lateral and third ventricles.' In his series are 15 ventriculograms in patients with verified lesions. Of these only one lesion lay in the mid-brain (Case 130) and in this case the ventriculogram indicated

"lesion of the posterior fossa" and led to a negative cerebellar exploration. In the present series, five infratentorial and two supratentorial cases are listed as misleading on account of failure to bear out these dicta. The difficulty of distinguishing these two groups of tumors on the basis of clinical findings has been repeatedly pointed out (11, 12). From the data presented in this paper, it seems that the solution is not to be found in all cases by means of ventriculography. This fact has also been pointed out by Bailey. Dandy, recognizing the difficulty, thinks it can usually be overcome by one's ability or failure to demonstrate the suprapineal recess in the third ventricle. This finding has not proved sufficiently dependable in this clinic to warrant a similar conclusion. Dandy also points out the fact that some pineal tumors produce pressure deformities of the posterior portion of the third ventricle. The group of cases presenting the greatest difficulty of course is that in which the lesion, primarily below the tentorium, has extended upward to cause both clinical and ventriculographic findings simulating a supratentorial lesion.

It is sometimes stated that suprasellar lesions obliterate (10) or deform (1) the third ventricle.

TABLE VII —POSTERIOR FOSSA

Case	Site	Lesion	Lateral ventricles	Third ventricle	Localizing value
77 S33021	Cerebellum	Abscess	Both dilated	Dilated	Positive
73 U1218	Vermis cerebelli	Ependymoma	Both dilated	Not visualized	Misleading
74 G443	Fourth ventricle	Papilloma	Both dilated	Dilated	Positive
75 U1711	Fourth ventricle	Papilloma	Both dilated	Dilated	Positive
76 U2908	Pons	Medulloepithelioma	Both dilated	Dilated	Positive
77 U12126	Left eighth nerve	Perineural fibroblastoma	Both dilated	Dilated	Positive
78 D470	Cerebellum	Spongioblastoma multiforme	Both dilated	Dilated	Positive
79 U12608	Fourth ventricle	Papilloma	Both dilated	Dilated	Positive
80 D1681	Vermis cerebelli	Medulloblastoma	Both dilated	Very faint but dilated	Positive
8 U15346	Cerebellum	Hemangioblastoma	Both dilated	Not visualized	Misleading
8 I115	Pons	Astrocytoma	Both dilated	Dilated	Positive
83 L205	Fourth ventricle	Medulloblastoma	Both dilated	Dilated	Positive
84 U17929	Left cerebellum	Sarcoma? medulloblastoma	Both dilated	Dilated	Positive
85 U2038	Left cerebellopontine angle	Meningeal fibroblastoma	Both dilated. Right distorted (1st decompression)	Dilated	Positive
86 U4445	Cerebellum	Tuberculoma	Both dilated	Not visualized	Misleading
87 U37405	Left cerebellum	Astrocytoma	Both dilated	Dilated 4th ventricle visualized	Positive
88 U12417	Cerebellum	Metastatic carcinoma	Normal	Normal	Misleading
89 U17093	Left eighth nerve	Perineural fibroblastoma	Both dilated	Slightly dilated	Positive
90 U22410	Vermis cerebelli	Astrocytoma	Both dilated. Peculiar bulging of roof of both	Slightly dilated	Positive
91 U12806	Right cerebellum	Medulloblastoma	Both dilated	Dilated	Positive
93 U19835	Vermis cerebelli	Spongioblastoma polare	Both dilated	Dilated	Positive
93 U17240	Fourth ventricle	Papilloma	Both dilated	Dilated	Positive
94 U1293	Cerebellar	Hemangioma	Both dilated	Dilated	Positive
95 U12436	Right cerebellar	Hemangioblastoma	Both dilated	Visualized but not apparently dilated	Indeterminate
96 C126	Pons	Spongioblastoma polare	Both dilated	Dilated	Positive
97 E1019	Vermis cerebelli	Astrocytoma	Both dilated	Very faint but dilated	Positive

\*See footnotes, Table II.



Such changes occurred in 3 (Table V) of the 5 cases in this series (Fig. 6). The variation in the findings in our supracellar cases is readily understood when one considers the variations in size, shape and direction of growth which these lesions exhibit.

In rare instances air in the ventricles brings into relief the positive shadow of a tumor not visualized on plain films. Such instances are Case 64, Table VI and Case 13, Table II (Fig. 4).

One common fallacy in the interpretation of ventriculograms we should like to point out. It is sometimes considered (8) that the darker sharply outlined triangular butterfly wings seen in anteroposterior (or postero-anterior) exposures with the face uppermost are the tips of the anterior horns, but this is not the case. The butterfly wings are the anterior portions of the bodies of the ventricles and the tips of the anterior horns are visualized as the fainter rounded shadows which are well separated (Fig. 7). It will be recalled that the anterior horns flare sharply laterally anterior to the foramina of Munro whereas the bodies are for the most part separated only by the septum pellucidum. The relationship is clearly demonstrated in the two roentgenograms shown in Figure 8.

Dandy states that every space occupying lesion can be localized by means of ventriculography. But in the present series are 5 cases with verified lesions in which ventriculograms interpreted as normal were obtained (Cases 11, 32, 48, 54, and 88). The lesions in 3 of these cases were on the surface of the cortex and in the 2 others were quite small. Normal ventriculograms (at least according to the interpretation in this clinic) are suggestive but by no means positive, evidence of the absence of a space occupying lesion.

It cannot be emphasized too strongly that pneumoventriculography is only an adjunct to neurological diagnosis though as such it may prove of inestimable value. However, as in the use of all contrast media, incomplete filling or failure to visualize a cavity should not be interpreted as infallible evidence of a pathological state. As has been pointed out there are relatively few definite localizing criteria and these are closely dependent upon the size, shape, and position of the lesion. No arbitrary table of ventriculographic signs can be made, but rather does each individual problem demand every available technical and intellectual effort for its solution.

It is a pleasure to express our gratitude to Dr. Ernest Sachs and Dr. Sherwood Moore for their permission to report the material contained herein and for their valuable help and suggestions.

## BIBLIOGRAPHY

1. ADSON, A. W. The evaluation of pneumoventriculography and encephalography. *Am. J. Roentgenol.*, 1934, xxvii, 657.
2. BAILLY, P. Intracranial Tumors. p. 433. Springfield, Charles C. Thomas, 1933.
3. BALADO, M., ALONSO, R., and DOMOVAN, C. La Radiografía del Tercer Ventrículo. *Arch. Argent. de Neurol.*, 1927, i, 237.
4. DANDY, W. E. Ventriculography following the injection of air into the cerebral ventricles. *Ann. Surg.*, 1918, lxxviii, 5. *Am. J. Roentgenol.*, 1919, vi, 56.
5. Idem. Localization or elimination of cerebral tumors by ventriculography. *Surg. Gynec. & Obst.*, 1920, xxx, 320.
6. Idem. Localization of brain tumors by cerebral pneumography. *Am. J. Roentgenol.*, 1921, x, 610.
7. DANDY, W. E. The Brain. *Lewis' Practice of Surgery*, ed. xii, p. 89. Hagerstown, Maryland, W. F. Prior Co. 1931.
8. DAVIS, LOVELL. Intracranial Tumors. *Ann. Roentgenol.* vol. iv, p. 80. New York: Paul B. Hoeber, 1933.
9. ELIASBERG, C. A., and SLEIGHT, S. The ventricular system. *Arch. Neurol. & Psychiat.*, 1925, xix, 596.
10. GRANT, F. C. Indications for and technique of encephalography. *Radiology*, 1927, ix, 353.
11. HORRAX, G. Differential diagnosis of tumors primarily pial and primary pontile. *Arch. Neurol. & Psychiat.*, 1927, xxvii, 179.
12. HORRAX, G. and BAILLY, P. Tumors of the pial body. *Arch. Neurol. & Psychiat.*, 1915, xiii, 423.
13. NAPPUNZIO, H. Personal communication. Also mentioned by Davis, loc. cit., page 97.
14. SACHS, ERNEST. Diagnosis and Treatment of Brain Tumors. p. 340. St. Louis: C. V. Mosby, 1931.

UNILATERAL DISLOCATIONS OF CERVICAL VERTEBRÆ WITHOUT ASSOCIATED FRACTURE<sup>1</sup>

BARBARA B STIMSON M.D. AND PAUL C SWENSON M.D. NEW YORK

UNILATERAL forward dislocations of the cervical vertebræ, complete or incomplete, without associated fractures, form a group of cases which because of the apparent ease with which the condition is acquired by the patient and the difficulty with which it is diagnosed by the doctor have seemed worthy of study. During the period from January 1, 1929, to July 1, 1933, 27 such patients have presented themselves to the Fracture Clinic of the Presbyterian Hospital and this paper is based on a study of this series of cases.

## HISTORICAL SKETCH

The condition apparently has been known since Hippocrates but no detailed descriptions are found until the last half of the eighteenth century, according to Malgaigne, when Desault recognized the condition in the living and Preis in 1789 provided the possibility of such a dislocation on the cadaver. Seiffert in 1831 reported 3 cases. Schuk in 1841 and others published reports of single instances. Malgaigne in 1855 gives a summary of the knowledge of this condition up to that time and cites 3 cases of his own and 14 he had collected in which the patient survived. He states that Newman in 1814 was able to reduce a cervical dislocation by manipulation but he was not sure whether Desault had been able to reduce one earlier. Since 1855 various cases have been reported both in Europe and this country most of them, however, dealing with more serious conditions than those described in this article. Langworthy in 1930 published a report of 13 cases of unilateral dislocation all without fracture, which is the largest single series we have been able to find.

This is, therefore, not the presentation of a new pathological lesion or a novel method of treatment. The aim is merely to give a composite picture of 27 cases, the methods of diagnosis, and the treatment which has been used with its results over a relatively short period of time.

## CLINICAL PICTURE

The patient walks into the Clinic or Emergency Ward complaining that he has twisted his head and cannot straighten it or that he awoke and found his neck crooked. Pain is present but is apt to be a secondary symptom. The onset is acute in

most instances and follows mild trauma—a jerk of the head to see a ball in the air—a sudden turn to answer a call, a bump in a car on a rough road—a twist of the head while dressing. Two dislocations in the present series occurred when the patient yawned. Inability to straighten his head accompanied by pain causes the patient to seek help usually within a few hours of injury. In this series 20 minutes was the shortest time which elapsed and 5 days the longest between onset and admission to the Clinic.

It may be of passing interest to note that of the 27 patients 18 were males. All of the series were under 40 years of age—15 between 10 and 20 years of age, and 8 between 20 and 30 years of age. The youngest patient was 6 and the oldest 38 years of age.

The picture these patients present when they apply for treatment is strikingly uniform. The head is held tilted and turned and the patient is obviously loath to change the position. If the articular facet is riding forward but has not slipped off, in other words if the dislocation is partial the head is apt to be tilted and turned to one side that away from the lesion (Figs. 1 and 2). If on the other hand the articular facet has slipped completely off and lies in the intervertebral notch the head is more apt to be tilted to the side of the lesion but turned away from it (Fig. 3). However, these findings are not constant in our series and authorities differ.

On further examination it is found that the patient is able to bend and turn his head further away from the injured side but all attempts to turn toward it are painful and resisted. When the patient tilts his head to the unaffected side the cervical spine curves in a gentle arc but when he attempts to bend to the opposite side the body moves as a whole the cervical spine remaining straight (Fig. 4). This is also demonstrated when the operator performs the motions passively. Flexion and extension of the neck are usually not much affected. When there is spasm of the muscles it is always on the side of the lesion regardless of the position of the head which is an important sign in differentiating the incomplete lesion from torticollis. Tenderness is also demonstrable in almost every instance at the site of the lesion. In some cases deviation of the spinous processes can be made out but in the milder forms this is very

<sup>1</sup>From The Department of Surgery, College of Physicians and Surgeons, Columbia University and The Fracture and Roentgenological Services, Presbyterian Hospital in the City of New York.

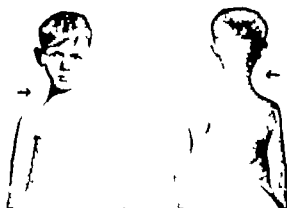


Fig. 2. Photographs showing the characteristic pose of the head. The spasm of the sternocleidomastoid on the long side of the neck is noticeable. The arrows designate the side of the lesion.

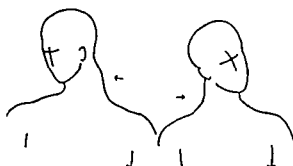


Fig. 3. Left. Drawing showing the tilt and rotation of the head in an incomplete unilateral dislocation. The arrow designates the side of the lesion.

Fig. 3. Drawing showing the tilt and rotation of the head in complete unilateral dislocation. The arrow designates the side of the lesion.

#### X-RAY EXAMINATION

seldom evident. There have been no symptoms suggestive of cord or nerve root lesions in this series of cases.

Given then a patient complaining of a twisted, painful neck following an inconsiderable trauma and showing the head turned and tilted to one side with tenderness and muscle spasm on the opposite side of the neck, the examiner is justified in making a tentative diagnosis of partial unilateral dislocation of a cervical vertebra pending the roentgenographic examination. Should the roentgenographic examination prove to be negative the examiner is still justified in assuming that a partial dislocation has occurred and has been spontaneously reduced leaving residual muscle spasm and soreness.

While the roentgenogram is not an absolutely essential diagnostic procedure, it has clinched the diagnosis in 26 of the 27 cases in our series. Certainly we must disagree with the rather broad statement made by Langworthy in 1929 that "the lesion cannot be shown by roentgenograms." Technically good films studied with care will, we think, reveal the point of dislocation in the majority of cases where otherwise it would be easily overlooked. Perhaps the only reason that all the dislocations are not recognized roentgenographically is due to the fact that there has been a subluxation of such minor degree that as mentioned above it may reduce spontaneously or with as little manipulation as is used in placing the patient for roentgenography.

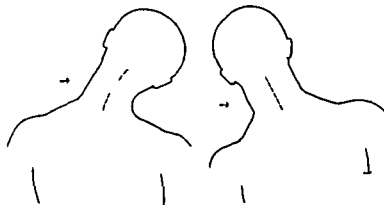


Fig. 4. Drawing showing the curve of the cervical spines when the head is inclined away from the affected side and the lack of curve when the head is inclined toward it. The arrows designate the side of the lesion.

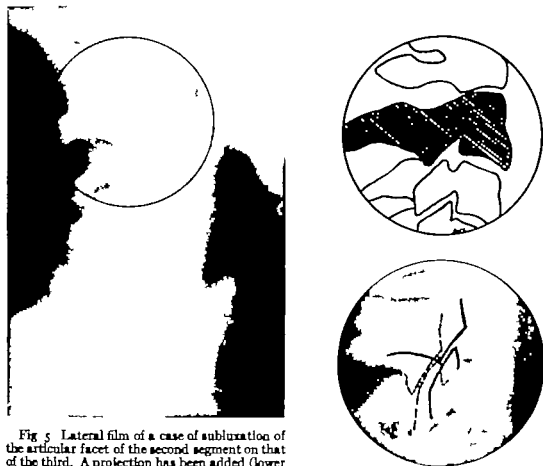


Fig. 5. Lateral film of a case of subluxation of the articular facet of the second segment on that of the third. A projection has been added (lower right) to enable us to outline the facet surfaces. The dotted lines show the normal facets. The heavy tracings show the surfaces where the dislocation exists.

Our routine films include a stereoscopic lateral projection of each side, a stereoscopic anteroposterior film at two different levels to allow for the tilt of the chin, as well as a special projection through the open mouth in order better to study the upper two cervical segments and the odontoid process. Occasionally a fracture without displacement may be found in this process—a fact which is of obvious importance.

Stereoscopic films are *essential* if minute deviations from the normal are to be recognized, and we therefore realize the difficulty and the relative futility of reproducing prints of flat films. We have therefore included a diagrammatic sketch with each print more clearly to depict the level of the lesion (Figs. 5 to 17, inclusive). These show one facet surface moved upward and forward on that of the one below. Sometimes a slight backward displacement of the corresponding facet on the opposite side can be recognized. This abnormal relationship of the facets may be the only recognizable finding. When there is associated with the unilateral subluxation a fracture of any of the component parts of the vertebra or a dislocation



Fig. 6. Anteroposterior projection of the same case as in Figure 5. The level of dislocation is unfortunately obscured by the characteristic tilt of the chin.

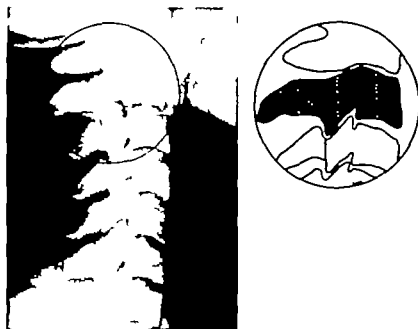


Fig. 7. Same case as in Figures 5 and 6—postreduction showing a normal relationship of the facets.



Fig. 8. Same case as in preceding films—postreduction anteroposterior film.

of the body of the segment the diagnosis is of course most obvious.

The objection may be raised that apparent dislocations may be seen and falsely "read into the films" because the films are not perfect lateral projections. This is certainly a difficulty to be kept in mind but even in somewhat oblique lateral



Fig. 9. A representative anteroposterior projection taken with the mouth open so as to eliminate the superimposed mandible shadow and show the odontoid process.

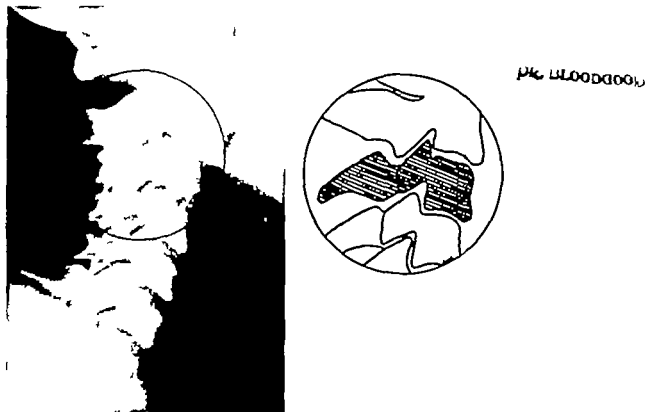


Fig. 10. Lateral film showing dislocation of facet of the third segment on that of the fourth.



Fig. 11. Anteroposterior projection in same case as in Figure 10. Note the larger superimposed facet shadow on the side of the partial dislocation.



Fig. 12. Same case as in Figure 10—lateral film (postreduction)



Fig. 13. Same case as in Figure 10—anteroposterior film (postreduction)

films the facet surfaces will not appear displaced upward and forward if one takes their anterior edges as an index or if the position of the posterior edge of the upper facet is compared with the anterior edge of the lower (Fig. 18). The position of the facets at the other levels at the same time appear equal. This will be the deciding factor. If in the lateral films, the posterior edges are used as an index, then we agree that the roentgen evidence is not reliable. The anteroposterior projections also are most useful in preventing incorrect interpretations, as in true subluxations they show a longer superimposed facet shadow on the involved side with a slight tilt of the spine to the opposite side at that level.

Our series of 27 cases reported here are all of the incomplete variety: the dislocated facet having in no case slipped completely forward into the intervertebral notch. In only 1 case did the X ray fail to show the lesion. In this particular case the examination was incomplete. The second segment was involved nine times, the third segment seven times, and the fourth and fifth segments five times each. One case as stated remains inconclusive.

The clinical interpretation as to the level of the lesion has shown a striking agreement with the X ray findings in all cases, the roentgenograms having been originally studied without knowledge



DR. BLOODGOOD



Fig. 14. Lateral projection showing a forward subluxation of the fourth on the fifth segment with the third also displaced on the fourth to a lesser degree.



Fig. 15. Anteroposterior film of same patient as in Figure 14. Note the larger superimposed facet shadow on the side of the partial dislocation.



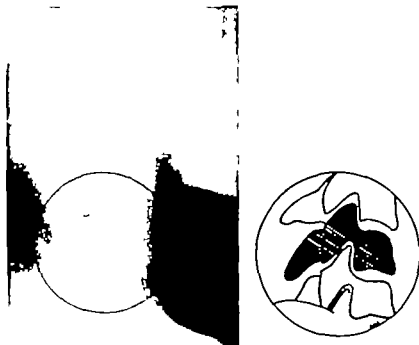


Fig. 16. Lateral film of patient shown in Figure 14 (postreduction)

of the clinical situation. This, we think, testifies to the fact that no false impressions have been developed as to the accuracy of the X-ray findings. If the roentgen examination has done no more than check the level of the supposed



Fig. 17. Anteroposterior projection of the same case as in Figure 14 (postreduction)



Fig. 18. Normal cervical spine (oblique projection) showing the anterior edges of the facets even, in spite of the distortion due to the oblique position. The opposing facet edges of the second and third segments have been heavily outlined.

TABLE I

Case	Manipulation	Traction		Plaster collar Duration	Leather collar Duration	Results
		Weight	Duration			
1		5 lbs.	48 hrs.			Patient lost
2		5 lbs.	1 wk.	7 days	3½ months	1 yr. full function
3	Without anæsthetic			0 days		5 wks. full function, lost
4		10 lbs.	18 hrs.	14 days		1 yr. full function
5	Gas and oxygen immediately		6 days	7 days	mon., 3 wks.	1 mon. full function
6	Gas and oxygen p 16 hrs traction	10 lbs.	16 hrs.	14 days	8 weeks	2½ mon. full function
7		10 lbs.	48 hrs.	8 days	11 weeks	6½ mon. full function
8	Spontaneous reduction			(felt collar) 8 days		Patient lost
9		1 lbs.	24 hrs.	7 days	1½ months	18 mon. full function
10		15 lbs.	48 hrs.	14 days	11 wks. 5 days	12½ mon. full function
11			48 hrs.	17 days	8 weeks	8 mon. full function
12		10 lbs.	48 hrs.	21 days	5 weeks	7 wks. full function
13		10 lbs.	24 hrs.	15 days	15 weeks	1½ mon. full function, aches p exertion
14	Gas and oxygen p 17 hrs traction	10 lbs.	17 hrs.	14 days	15 weeks	6 mon. full function
15		10 lbs.	18 hrs.	16 days	(felt collar) 1 month	8 mon. full function
16		22 lbs.	18 hrs.	25 days		8 mon. full function
17		10 lbs.	20 hrs.	60 days		yr. full function
18		7 lbs.	48 hrs.	1 day	13 weeks	mon. full function
19			48 hrs.	15 days	10 weeks	1 wks. full function, lost
20		1 lb.	24 hrs.	18 days		Recurrence 1 5½ mon.
21		8 lbs.	26 hrs.	42 days		6 mon. full function
22		10 lbs.	48 hrs.	(felt collar) 21 days		6 mon. full function
23		10 lbs.	24 hrs.	21 days	5 weeks	mon. full function
24	Gas and oxygen p 36 hrs traction	10 lbs.	36 hrs.	38 days		Recurrence at 7 wks
25		7 lbs.	24 hrs.	20 days		2½ mon. full function
26		10 lbs.	8 hrs.		18 days	1 wks. pain over mandible, lost
27		10 lbs.	20 hrs.	3 days		½ mon. full function

\*Re-dislocated in plaster after 1 week, put in traction for 6 days, then plaster for 1 month, followed by leather

†Recurrence after 2½ months.

‡Recurrence after 7 weeks.

lesion and has ruled out further fractures and dislocations it has served a real purpose. With films carefully made the percentage of error should not be high.

#### TREATMENT

When the diagnosis has been established, treatment should be at once instituted. Two methods are available—manipulation, preferably under a general anæsthetic, or traction by means of some form of head-piece. Occasionally reduction occurs spontaneously during some part of the examina-

tion or under the anæsthetic before any manipulation has been attempted. In the incomplete type head traction of about 10 pounds with the head of the bed on high shock blocks has been found to reduce the dislocation in a number of cases. In the present series 1 reduced spontaneously during the taking of X rays 1 was reduced by manipulation without anæsthetic, 4 were reduced by manipulation under nitrous oxide gas-oxygen, and the 21 remaining by head traction which was maintained usually from 18 to 48 hours. One case

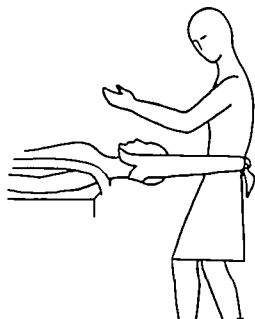


Fig. 9. Drawing showing a method of traction by means of a swathe around the patient's chin and occiput and tied around the operator's waist.

was reduced in 2 hours of head traction, 10 pounds applied by a Crile head piece.

The method of manipulation most frequently used is attributed to Walton who described it in 1892 and consists of extending the head diagonally backward toward the side of the convexity of the neck, thereby elevating the articular process. A slight rotation then restores the normal position. It is interesting to find a very similar procedure described by Malgaigne—*Le procédé le plus simple consiste à appuyer les deux genoux sur les épaules du blessé, pour faire la contre-extension à embrasser le menton avec les deux mains pour attirer la tête en haut d'abord puis de côté opposé à la luxation et l'apophyse*

*ainsi dégagée à la reporter à sa place par un mouvement de rotation.* In the complete type considerable traction is needed and can be supplied by a muslin or flannel bandage around the patient's chin and occiput and tied around the operator's waist—thus leaving his hands free to manipulate the neck (Fig. 19). Countertraction from the shoulders to the foot of the table is essential.

That a satisfactory reduction has been accomplished by manipulation or by traction can be ascertained (1) by the absence of the pre-existing deformity (2) by the freedom of motion of the neck, especially lateral bending, as previously described (3) by follow-up roentgenograms which should always be obtained.

After reduction by either means a well fitting, carefully molded plaster collar is applied and kept on from 1 to 4 weeks (Fig. 20). In 14 cases the plaster collar was followed by a leather one which the patient wore from 8 to 16 weeks. The table summarizes the treatment used in the 27 cases under discussion. It is of some interest that in Cases 20 and 24, in which the patients wore plaster collars for 4 weeks but no protection thereafter they returned, with a recurrence of symptoms, 1 after 5½ months and 1 after 7 weeks. Sixteen patients followed for 6 months or more after the conclusion of treatment report no further trouble. Six patients show satisfactory results at the end of 3 months. In the 5 remaining cases the patients were lost track of.

It is quite possible that not all cases need such extensive and prolonged protection but as yet we are not ready to give any criteria by which to judge the possibility of recurrence in any given case. Undoubtedly those patients who show little or no X-ray evidence of dislocation or in whom reduction has been spontaneous have undergone less damage to the soft parts and would therefore require a shorter period of treatment than those who have shown definite mal-alignment roent-



Fig. 20. Anterior, lateral, and posterior views of the type of plaster collar used.

genologically and who have required manipulation or continued traction. Further study of more cases over a longer period of time is necessary before definite conclusions on this point can be reached.

#### SUMMARY

A study of 27 cases of unilateral dislocation of the cervical vertebræ without fracture has been made and the clinical and X ray picture presented in an attempt to emphasize the relative fre-

quency and facility of occurrence and the ease of diagnosis.

#### BIBLIOGRAPHY

1. LANGWORTHY MITCHELL. J. Am. M. Ass. 1930 xciv 86
2. MALGAIGNE, J. J. Traité des Fractures et des Luxes. Gona. Paris, 1847
3. SCHUK. Am. J. M. Sc., 1841 ii, 207
4. SEIFFERT. Mag. f. d. ges. Heilk. 1831 xxxiv 419
5. WALTON G. L. Internat. Clin. (2nd series) 1892 ii, 207 J. Nerv. & Ment. Dis. 1893, xx, 609

# PREGNANCY AND PARTURITION FOLLOWING BILATERAL URETERAL TRANSPLANTATION FOR CONGENITAL EXSTROPHY OF THE BLADDER

LAWRENCE M. RANDALL, M.D. ROCHESTER, MINNESOTA  
*Section on Obstetrics and Gynecology The Mayo Clinic*

ROBERT S. HARDWICK, M.D. ROCHESTER, MINNESOTA  
*Fellow in Obstetrics and Gynecology The Mayo Foundation*

ONE hundred forty five patients with congenital exstrophy of the bladder were seen in The Mayo Clinic in the 20 years between 1912 and 1932. Thirty five of these, 84.1 per cent, were females. Twenty-eight of the 35 have undergone bilateral transplantation of the ureters into the sigmoid. Subsequently 5 of the 28 have married and 4 of these have borne children. Three have been confined elsewhere, and 1 on our service. One patient has had three children, one has had twins, and two have had one child each. The histories of the 4 who have borne children have been reviewed, and the subsequent course of the patients brought up to date in our follow-up records.

## REPORT OF CASES

**CASE 1.** The patient registered in October 1913, when she was aged 30 years. Her family history was negative. The menses had commenced at the age of 9 years, the interval was 25 days, flow was 5 days in duration, and moderate in amount. General physical examination gave negative results. Roentgenograms of the pelvis gave evidence of wide separation of the pubic bones, the pelvis otherwise was apparently normal. Both ureters were transplanted into the sigmoid by means of an operation in two stages, and later the bladder was excised. At the time of the transplantation it was noted that the internal genitalia were normal. The subsequent course was uneventful, and the woman married 6 years later in 1919. At the age of 38 years she had what was considered to be a miscarriage after gestation of 4 weeks. At the age of 41 years she conceived again, and pregnancy was uneventful aside from mild hyperemesis gravidarum in the early weeks. Approximately 6 weeks before term the membranes ruptured. She gave birth, elsewhere, spontaneously 1 twin; epiotomy was performed. Both children lived and presented no anomalies. For a few months following delivery the woman complained of pressure in the pelvis, and the cervix presented at the introitus. Since then, however, she has been well and is now 50 years of age.

**CASE 2.** The patient registered in 1917 when she was aged 22 years. Her family history and personal history were negative. Her menses had begun at the age of 9 years, the interval was 25 days, the duration of flow was 4 days, and there was moderate dysmenorrhea at the onset. General physical examination gave negative results. Roentgenograms gave evidence of separation of the pubic bones. Bilateral transplantation of the ureters was done in separate stages, at which time it was noted that the internal genitalia were normal. Subsequently the bladder was removed. Seven years later elsewhere, the patient gave birth to a living child spontaneously and at term. Two

years after this parturition she was delivered, also elsewhere, of a stillborn infant; the cause of the non-viability of the child was unknown. Both of the pregnancies and labors were essentially uneventful. Eight months following the last delivery she was seen at the clinic because of a complaint of prolapse. At that time appendectomy, suspension of the uterus, and plastic closure of the external vaginal wall were effected. The woman again became pregnant 2 years after the abdominal operation, and gave birth at term, spontaneously; her subsequent course has been uneventful.

**CASE 3.** The patient was first seen in the clinic in 1917, when she was aged 9 years; the parents were advised to postpone treatment of the exstrophy of the bladder until the girl was somewhat older. She was brought to the clinic again in 1921 at the age of 13 years, and gave an essentially negative past history. The menses had begun at the age of 12 years, the interval was 28 days, flow was 5 days in duration, and moderate in amount. The ureters were transplanted into the sigmoid in two stages, at which time the internal genitalia were found to be normal. The patient returned 8 years later when she was aged 20 years; at that time the bladder was removed and the introitus of the vagina was stretched under anesthesia. She married following her return home and became pregnant at the age of 22 years. The course of the pregnancy was uneventful, and the woman was delivered, elsewhere, by cesarean section, of a child weighing 5 pounds, 15 ounces (approximately 2.7 kilograms). The postpartum course was uneventful and the patient's health apparently has not been effected by the pregnancy.

**CASE 4.** The patient was first seen in the clinic in 1916 when she was aged 3 years. Two brothers had been born with congenital exstrophy of the bladder and both had died at the age of 5 months. Roentgenograms of the pelvis gave evidence of separation of the pubic bones. When the girl was aged 4 years, in 1917, the ureters were transplanted into the sigmoid in two separate operations. The patient re-entered the clinic when she was aged 15 years, in 1931, and at that time general physical examination gave negative results. She had begun to menstruate when she was between 12 and 13 years of age, the interval was 25 days; flow was of 3 to 4 days in duration and was moderate in amount. At the time of this second visit to the clinic the bladder was removed.

The patient entered the clinic again when she was 20 years of age, in the seventh month of her first pregnancy. Anal sphincteric control had been excellent at all times following transplantation of the ureters, and the patient had not noticed incontinence in this regard during her pregnancy. She complained of a great deal of backache, was sensitive over both sacro-iliac joints, and had been unable to wear a girdle because of abdominal discomfort. General physical examination gave essentially negative results. The blood pressure was 120 millimeters of mercury systolic and 80 diastolic; examination of the eye grounds gave negative results; the value for urea was 24 milligrams per 100

cubic centimeters of blood, and the value for hemoglobin was 75 per cent. The fetus was presenting by vertex, was deeply engaged in the pelvis, and the head was almost on the pelvic floor. The external pelvic measurements all exceeded the usual normal. The pubic bones were separated 5 centimeters. The sacral curve, as far as it could be palpated, was normal. The perineum was very long, because the vaginal introitus was directly between the two ends of the ununited pubic bones. The woman was kept under observation for 8 days, during which time the discomfort in the back persisted. No definite renal tenderness could be elicited nor could evidence of hydronephrosis be discovered by palpation. On two occasions the temperature was 101 degrees F., without any obvious reason. It was felt that she probably had pyelitis.

Labor began spontaneously 8 days after the patient's admission, when gestation was approximately of 38 weeks' duration. The first stage of labor was uneventful and rapid during this time the cervix and presenting part rested on the pelvic floor. Deep, left, mediolateral episiotomy was done, and a male child weighing 5 pounds and 10 ounces (2.5 kilograms) and 18 inches (46 centimeters) in length was delivered. Presentation was compound, a foot and the vertex appearing at the introitus. The total length of labor was 3 hours and 6 minutes. Following delivery of the child, the cervix and lower uterine segment prolapsed through the introitus, the incision of episiotomy was repaired, and an iodoform pack was placed in the vagina because of the prolapse. On the first day postpartum the temperature was 101 degrees F. and on the eighth day 101 degrees F. An intravenous urogram was made on the twelfth day which gave evidence that the right and left renal pelvis were normal, and the right and left ureters, dilated throughout. The subsequent course has been uneventful, except for moderate uterine prolapse which is being observed by her physician at home.

Search of the literature (1 to 17) reveals that 28 children have been born to 20 women who had congenital ectrophy of the bladder, including the cases reported here. Five of the deliveries were by cesarean section, and 1 patient underwent this operation twice. Vaginal delivery was accomplished in 23 cases. Fifteen of these were spontaneous with the vertex presenting. Three patients were delivered by instruments, 2 by version and 2 by breech extraction. Record of the details of one confinement are unavailable. Seven children were stillborn and 21 were born alive. To the best of our knowledge there was no instance of the child having an anomaly similar to that of the mother.

The management of pregnancy of patients who are in the condition with which we are concerned has not received any special consideration. This probably arises from the fact that few such patients have lived sufficiently long to have children, and from the fact that most of them have not had the benefit of modern surgical care for the ectrophy that is, transplantation of the ureters and subsequent cystectomy. As time goes on, however more and more of these women probably will live to adult life and with the hitherto hope

less deformity corrected, will marry. Genital anomalies apparently afflict a very small percentage of these patients hence, their reproductive capacities are interfered with but little. It would seem essential that renal function be normal and evidence of renal infection be absent if these women are to attempt to become pregnant. Excretory urography will help to determine the condition of the kidneys and of the ureters. Close observation before delivery is obviously necessary. Urinalysis is impossible hence more dependence will have to be placed on readings of blood pressure and on estimations of increase in weight. Examination of the ocular fundi estimation of the urea content of the blood, and determination of the values for serum proteins and serum sulphate will aid in following the condition through gestation.

The type of delivery for these patients would seem to hinge on the question of possible deleterious effect of vaginal delivery on the result of the operations for ectrophy of the bladder. It is difficult to see how the transplanted ureters could be injured in any way by labor if they have tolerated the pregnancy. Hence cesarean section does not seem indicated solely because these patients have undergone previous ureteral transplantation and cystectomy.

The pelvic cavity is usually of justo-major proportions with a defect of several centimeters in the anterior portion of the girdle so that disproportion in the ordinary sense between the presenting part and the pelvis will not exist. Premature labor probably will occur in these cases more often than among patients whose pelvis do not display this abnormality. It did occur in 2 of the 4 cases here reported. This fact, coupled with the large pelvis and small child may lead to compound presentation, as in Case 4 when a foot presented with the vertex.

The all important point in relation to delivery through the vagina is preservation of the anal sphincter. The integrity of this muscle must be preserved for the comfort of the patient, and the good result from the ureteral transplantation is dependent entirely on the ability of the anal sphincter satisfactorily to hold urine in the bowel. Because of the fact that the perineum is extended ventrally the vaginal introitus usually is between the ununited edges of the pubic bones. In the case in which we performed delivery the pressure of the presenting part was directed low on the perineum, and because of the large pelvis there was interference with the usual mechanism of deflexion. Consequently, delay in the second stage of labor with strong uterine contraction might

lead to deep laceration of the perineum and possible injury to the anal sphincter. In addition because absence of the bladder brings the anterior wall of the vagina into closer relationship with the peritoneal cavity these tissues should be protected. The second stage of labor is concerned with passage of the presenting part over the perineum for the vertex or breech comes to rest on the perineum immediately the cervix is dilated. It would seem that the perineal stage of labor should be treated by early and sufficient medio-lateral episiotomy. Because of the importance of the anal sphincter median episiotomy should be avoided.

Prolapse of the uterus is a common postpartum complaint of these patients. In one of our cases, uterine suspension was necessary following two confinements. This patient has since borne a child without recurrence of the prolapse. The tendency to uterine prolapse may be used as an argument for cesarean section in these cases.

The question of the number of pregnancies that these patients may undergo cannot be settled on the basis of present knowledge. The 7 deliveries at term of 4 patients have produced nothing more serious than uterine prolapse as a definite undesirable sequel.

It is of interest, in these 4 cases, that so far as we were able to determine only 1 of the patients manifested evidence of urinary infection during pregnancy. Inability to examine the urine, of course, makes a definite diagnosis impossible. In 1 case there seemed to be no certain explanation for the temperature of 101 degrees F that was observed during the period before delivery.

The ability of any of the 4 patients to maintain sphincteric control, even during the latter part of pregnancy apparently was not affected. The intravenous urograms taken on the twelfth and fourteenth days postpartum in Case 4 gave evidence of the same type of ureteral dilatation that is seen during pregnancy and in the early part of the puerperium of many gravid women. It is probable that this dilatation persisted longer in this case and it raised the question of whether there may not be some permanent dilatation of the ureters. In Case 4 also, the patient complained of pain in the lumbosacral region and in the lumbosacral joints. We felt that this pain

probably was related to the strain on the incomplete pelvic girdle. The compound presentation in Case 4 did not complicate delivery in any way. Three of the patients presented essentially just-major pelvis, and delivery was uneventful in each of these cases.

## BIBLIOGRAPHY

1. ADAM, JAMES. Case of ectrophy of bladder and split pelvis complicating labor. *J. Obst. & Gynec., Brit. Emp.* 1903 II, 377-380.
2. ARMSTRONG-GREENE, V. B. Complete ectrophy of the bladder with split pelvis. *J. Obst. & Gynec., Brit. Emp.* 1926, xxxviii, 436-438.
3. AYRES, D. Congenital Ectrophy of the Urinary Bladder and Its Complications Successfully Treated by a New Plastic Method. New York, 1859.
4. BOOTHBY, JOHN. On the preterminal structure of the podenda in a woman. *Phil. Tr. Lond.* 1722, vii, 42-43.
5. EBERHARD, C. W. and FRENCH, J. M. Pregnancy terminated by cesarean section after ureteral transplantation into the sigmoid. *Surg. Gynec. & Obst.* 1928, xlviii, 540-542.
6. GUNZENBERG, M. Geburt bei gespaltenem Becken und Ectropie der Harnblase. *St. Petersburg. med. Zeitschr.* 1872, lii, 525-528.
7. GUNZENBERG, A. Ein Geburtsfall bei gespaltenem Becken. *Berlin. klin. Wchnschr.* 1879, xvi, 13-5.
8. HAMILTON, H. A. A singular malformation. *Boston M. & S. J.* 1835, xi, 93-96.
9. KLEIN, THEODORE. Eine Geburt bei Spaltbecken mit Blasenectropie. *Arch. f. Gynaek.*, 893, xlii, 549-553.
10. LEIDMANN, C. C. T. Das gespalte Becken. *Arch. f. Gynaek.*, 872, lv., 266-284.
11. MAYO, C. H. and HENDERSON, W. A. Ectrophy of the bladder. *Surg. Gynec. & Obst.* 1906, xlii, 129-134.
12. MILLER, C. J. and KING, L. L. Complete ectrophy of the bladder with split pelvis as a complication of pregnancy. *Am. J. Obst.*, 1918, lxxviii, 267-273.
13. MOOREHEAD, J. J. and MOOREHEAD, E. T. Ectrophy of bladder report of two cases. *J. Am. M. Ass.* 1916, lvi, 409-411.
14. SAOY, E. C. An unusual example of ectrophy of the bladder with marked separation of the pubic bones. *Am. J. Obst. & Gynec.*, 1924, viii, 497-500.
15. SCHROEDER, G. Beitrag zur Lehre des normalen und gespaltenen Beckens. *Beitr. z. Geburtsh. u. Gynaek.* 1901, iv, 243-272.
16. WALDEBYER, E. Ein Fall von Bauch- und Beckenspalte, Epispadie und Ectopie vesical. *Monatschr. f. Geburtsh. u. Gynaek.*, 1897, vi, 273-300.
17. WINDSLOW, RANDOLPH. Report of a case of ectrophy of the bladder operated on nearly thirty years ago with subsequent history. *Surg. Gynec. & Obst.* 1916, xvi, 350-352.

## CANCER OF THE VULVA

WITH A REPORT OF ONE HUNDRED EIGHTEEN CASES

ARD F SCHREINER, M.D., F.A.C.S. AND WILLIAM H WEHR, M.D., BUFFALO NEW YORK  
State Institute for the Study of Malignant Disease, Barton T. Simpson, M.D. Director

CANCER of the vulva is not rare. It is regarded as a very malignant disease, one in which recurrences after treatment are frequent, and if left untreated, it usually runs a rapidly fatal course, although occasionally exceptions may be observed.

According to some gynecologists, cancer of the vulva is rare. Brady (quoted by Stout) in reviewing 29,000 admissions for gynecological disease at the Johns Hopkins Hospital, observed only 27 cases of vulvar cancer. Stout did not observe any at the Presbyterian Hospital in a period of 10 years. Graves and Smith, in 1929 reported 21 cases observed at the Women's Free Hospital in Boston, and Clark and Norris, in their book *Radical in Gynecology* reported 30 cases of carcinoma of the vulva among 1,119 specimens of malignant new-growths in the gynecologic laboratory of the University of Pennsylvania. These latter two authors quote Schaefflander and Kernmanner as saying these tumors represent from 2 to 4 per cent of all genital carcinoma.

Ewing says that cancer of the vulva is not rare. We find among 18,379 cases admitted to the State Institute from January 1913 to May 1, 1933, that 11,737 lesions were proved malignancies that 1,587 of these involved the cervix uteri, 340 the fundus of the uterus, 83 the vagina, 204 the ovary, 118 the vulva, and 12 the female urethra. These 118 cases comprise 1 per cent of all our cancer cases and 5 per cent of all our female genital carcinoma, not including the urethra. This 5 per cent is more than would be observed in the average general hospital.

Among our records we also found 31 benign lesions of the vulva, as follows: 7 benign papillomata, 4 cysts and 20 inflammatory lesions, including pruritus, eczema, kraurosis, abscess, leucoplacic vulvitis, 1 tuberculous ulcer, and other inflammatory lesions.

## ETIOLOGY

Graves and Smith, in an article "Kraurosis Vulvae" give an historical review laying stress on the confusion of this condition in the literature, and after clinical and histological study of cancer of the vulva, are convinced that leucoplacia and kraurosis are demonstrable in a large percentage

of the definitely proved malignancies. In 21 specimens of epithelioma of the vulva they found kraurosis 14 times and leucoplacia 16 times. They are therefore, of the opinion that kraurosis and leucoplacic vulvitis are in all probability phases of the same disease. Taussig is of the opinion that leucoplacic vulvitis frequently undergoes malignant change and that if this condition were treated surgically, the occurrence of cancer of the vulva could be reduced 50 per cent. Twenty-one of the 118 cases of vulvar cancer admitted to the Institute, showed evidence of leucoplacic areas, clinically.

In the histories given by the patients in our series 52 per cent complained of itching and burning extending over a period of weeks, months, or years, before the establishment of malignant growths. It would seem from this that the changes associated with the conditions that produce the intense itching and burning in pruritus vulvae must be regarded as an etiological factor on the theory that chronic irritation is one of the causes of malignancy. Ewing says that "The parakeratosis and round-cell infiltration of the corium in pruritus are distinctly favorable to the development of epithelioma." Other patients complained of pain and a bloody or purulent discharge which at times had a very offensive odor. Very few of them were cognizant of any growth being present.

One hundred and eight of the patients were married, 13 of whom were nulliparae. Ten were unmarried and the others had from one to seven pregnancies.

Ages of patients at the time of admission

Age in years	Cases
25	1
30 to 39	8
40 to 49	30
50 to 59	23
60 to 69	34
70 to 79	20
80 to 83	3

The youngest patient in this series was 25 the oldest, 83.

In recording cancer of the vulva, we have included the labia, major and minor, the fourchette, the clitoris and Bartholin's glands. The 12 cases of primary epithelioma of the female urethra and



TABLE I.—RESULTS OF TREATMENT IN GROUP I

	Cases
Admitted and treated 5 or more years ago	9
Free from disease—	
For 11 years	
For 8 years	
For 7 years	
For 6 years	
Palliation—lived over 4 years—	3
Lenses controlled for 6 years when metastases developed in groin and patient died from local extension and metastases 7 years after admission	
Lenses needed and controlled for 2 years death 3 years after admission	
Death—	
In less than year	
to years	
to 3 years	
to years, clinically well years, 3 months	3
Clinically well year—died from other cause	
Last trace of	
Admitted and treated less than 5 years ago	3
Free from disease following original treatment—	
More than 3 years	
For years	
For 6 months	
For 6 months	
For months	
Palliation—clinically well 4 years, local recurrence death from local extension and metastases in year	
Clinically well, death from other cause in years, 4 months	

metastatic tumors to the vulva from other parts of the genital tract are not included in this report.

In the 118 cases of cancer of the vulva, biopsy showed epithelioma 115 times in one of which there was a mixed lesion showing both pearl and basal cell epithelioma and adenocarcinoma 3 times. One of these adenocarcinoma definitely had its origin in Bartholin's gland the 2 other adenocarcinoma were probably primary in some of the sweat glands of the vulva. These findings are in accord with Professor Ewing's statement that most of the malignancies occurring on the vulva are of epidermoid origin that Bartholin's glands and sweat glands may also be the origin of adenocarcinoma.

Melanoma of the vulva is a rare disease but exceedingly malignant. Wright, in a recent paper "Melanoma of the Labia," reported 3 cases and reviewed the literature. Leichter reported a basal cell epithelioma of the vulva in 1929 (Stout)

#### PATHOLOGY

Cancer of the vulva may occur as a thickening of the epidermis which soon becomes cracked or fissured as a warty or papillomatous growth which is primarily malignant, a benign wart upon which the malignant process is ingrafted or as an infiltrating type of growth which soon ulcerates giving rise to bloody or purulent discharge and pain. It is often associated with a history of pruritus vulvae, kraurosis or leucoplacic vulvitis.

Secondary infection with ulcerating or excoriated lesions causes a rapid proliferation and dissemination of the disease to lymph bearing areas.

In 62 per cent of our primary cases (those not operated upon before admission) the inguinal lymph nodes were distinctly enlarged. The spread of the disease from the vulva is by contiguity of tissue or through the lymph channels into the femoral and inguinal lymph nodes. Those lesions which have their origin in the clitoris or immediately surrounding it may metastasize through the deep lymphatics into the pelvis. Disseminated metastases do occur involving the abdominal and thoracic viscera. When syphilis is combined with epithelioma of the vulva the prognosis seems to be more unfavorable. In our series, 11 cases were associated with syphilis. Nine of these patients died in less than 1 year but 1 is living for over 6 years, and 1 died over 4 years after admission.

Multiple lesions involving the vulva have been observed. Whether they were due to lymphatic extension or direct contact, is difficult to state.

"Epithelioma of the vulva usually presents a structure of narrow cords and columns of relatively undifferentiated squamous cells. Hornification and pearl formation are not prominent. The malignant clinical character of the process is often apparent in the histological structure. In the advanced stages, the proportions of cells and stroma vary and some authors speak of scirrhous and encephaloid types." (Ewing)

#### TREATMENT

The treatment of cancer of the vulva whether by surgery, coagulation, or a combination of these methods with irradiation, or irradiation alone has proved very unsatisfactory. This is especially true when the lesion on the vulva has attained any size and has existed for several months, as the problem then is not only eradication of the local lesion but the more difficult problem of eradicating metastatic nodes in the lymph bearing areas.

Tausig believes the treatment of choice is radical surgery. In a report of 49 cases of vulvar cancer treated over 5 years ago, of which 11 were operated upon radically according to the Basset technique, he says that 81 per cent have resulted in 5 year healings. Two cases recurred 1 at 5½ years, and 1 at 8 years, making an absolute cure of 63 per cent of these 11 selected cases. We are of the opinion that radical coagulation of the vulva and highly filtered X ray or radium to the lymph bearing areas is applicable to a larger number of cases presenting themselves for treatment.

Cade, one of the English workers, fosters the implantation of radium needles into the vulva and surface applications of radium at 1¼ centimeters distance over the groins.



Fig. 1



Fig. 2

Fig. 1. Case M. C. Group I case before treatment was started.

Fig. 2. Case M. C. Photograph taken 7 months after coagulation of the vulva and high power X-ray treatment.



Fig. 3

over the vulva and groins. Patient has remained free from the disease 7 years and 8 months.

Fig. 3. Case H. P. Group I case showing papillary type of growth. Admitted November 1932.

We are cognizant of the fact that vulvar cancer treated surgically by vulvectomy and radical excision of the lymph bearing areas, when the lymph nodes do not show metastases, sometimes cures. However, when metastases are demonstrated in the lymph bearing areas, cures are very exceptional. In reporting the results of treatment of cancer of the penis (Schreiner) we demonstrated that radical surgery gave excellent results if there were no demonstrable metastases in the lymph bearing areas. From our experience it would seem that the same thing holds true for vulvar cancer. Radical surgery would, therefore have a very limited field for the cases presenting themselves for treatment at our institution.

The treatment of our series of cases has been of necessity, changed from time to time as experience was gained. Patients treated prior to 1923, as we see it now were very inadequately treated, especially radiologically. Better palliation resulted from coagulation of the local lesion and heavily filtered irradiation over the lymph bearing areas than from any other method.

Recently a few of the vulvar lesions treated with heavily filtered radium needles inserted through the local lesion and heavily filtered radium packs to the lymph bearing areas, have responded so well that it has given us more hope.

Rentachler reports 71 cases treated in the Mayo Clinic by surgery, irradiation and combinations, and concludes that only 13 were alive and free from the disease from 1 to 15 years.

In reviewing the work of the Teubinger Clinic, Tausch records 39 cases of vulvar cancer in which 19 per cent lived 5 years, but records only a 7 per cent absolute cure.

Schulz reports 3 cases alive 5 years after treatment or 13 per cent of his 23 cases of cancer of the vulva. The report includes 43 cases but his statistics were based on 23 cases in which treatment was surgical.

Dr. Berven of Radiumhemmet, in response to a recent communication, stated that in 34.9 per cent of his cases patients have remained free from the disease 5 years or longer.

Delporte and Cahen in reviewing 11 cases of vulvar cancer treated by irradiation both radium and X-ray supplemented by surgery report some healings of the primary lesions and regression of the enlarged nodes by irradiation but they also seem somewhat discouraged in view of the extreme malignancy of these lesions especially when the lymph bearing areas are involved.

#### RESULTS OF TREATMENT

Our 118 cases were divided into three groups according to the amount of anatomical involvement. Twenty-seven cases in which the disease was local, no matter how extensive but with no definite clinical signs of metastases in the groins were placed in group I. Forty four cases in which the lymph nodes in one or both groins were distinctly enlarged and were thought to be metastatic, fell into group II. Twenty of these cases



Fig. 4



Fig. 5



Fig. 6

Fig. 4. Case H. P. Lesion healed following coagulation of the local lesion and high power X-ray treatment over the groins.

Fig. 5. Case E. T. Group II case before treatment.

Fig. 6. Case E. T. Photo taken 3 years after original treatment of coagulation of the local lesion and irradiation over the groins. This patient is alive over 7 years after admission.

were considered absolutely hopeless. Forty seven of our cases had been treated surgically before admission. The patients had had either local excision of the lesion, or radical operation, followed by recurrence. These were placed in group III.

In only 72 of the 118 cases of cancer of the vulva were the patients treated 5 or more years ago.

TABLE II—RESULTS OF TREATMENT IN GROUP II

Admitted and treated 5 or more years ago	Cases
Living over 15 years—	24
Lived 7 years, 6 months—free from disease 7 years, 10 months, then local recurrence—luch was treated and patient remained well for 7 years, 6 months when there was local recurrence—luch has been healed after further treatment, for past 3 months	
Lived 6 years with no recurrence of local lesion since original treatment but nodes in both groins were retreated 2 years after admission—palpable nodes since then	
Deaths—	
Is less than 3 year	8
Hopeless at time of admission	
Is to 3 years—local lesion well at time of death	
Is to 3 years—local lesion well at time of death—can be healed at time of admission	
Not treated	
Admitted and treated less than 5 years ago	30
Free from disease following original treatment—	
For 7 years, 9 months	
For 7 years, 6 months—hopeless	
Living July 1, 1937—	
For 3 years, 10 months—disease progressing	
Free from disease 7 and 6 months, respectively, nodes still palpable in groins—hopeless at time of admission	
Chemically all months—local recurrence—clinically well following further treatment for 3 months, now undergoing treatment for another local recurrence	
Deaths—	
Is less than 3 year	6
Hopeless at time of admission	
Is to 3 years	
Is to 3 years—chemically all years, recurrence and metastases	

Nineteen of these cases were in group I 8 or 42 per cent have lived over 5 years but only 6 or 31.5 per cent, have remained free from the disease for a period of 5 years or longer (see Table I).

In these 6 cases the patients were treated in the following manner: 3 were treated only by radiation of the local lesion only; and 4 by irradiation of the local lesion, irradiation of the lymph bearing areas, followed by coagulation of the vulva.

None of the group II cases in this group of 72 cases resulted in 5 year healings, although 2 of the patients are living over 5 years and have been free from the disease for periods up to 4 years. Of course 11 of these cases were considered absolutely hopeless before any treatment was administered. Ten of these died within a few months but 1 lived for over 2 years and the local lesion healed (see Table II).

Three of the 39 group III cases, treated 5 or more years ago or 10 per cent, lived over 5 years. Two of them, or 7 per cent, have been free from the disease for a period of 5 years or longer. The other one suffered a recurrence after being free from the disease for 4 years and 10 months and died 6 years and 5 months after admission. One of the patients, counted as a 5 year healing is living for 17 years after admission although she has had two local recurrences which responded to treatment (see Table III).

The absolute statistics of all the cases treated 5 or more years ago regardless of clinical grouping on admission, are 13 of 72 or 18 per cent, have



Fig 7

Fig. 7 Case A. A. Showing a rare tumor of the vulva—adenocarcinoma of Bartholin's gland. (Patient alive and well but have been unable to get photograph of healed lesion as patient does not report for examination.)



Fig 8



Fig 8

Fig 8 Photographs of 2 cases, in neither of which the patients had had treatment at the time of admission. In both the condition was regarded as hopeless when patients entered the hospital.

lived 5 years or longer 8 of 72 or 11 per cent, have been free from the disease for periods of from 5 to 11 years and are living since admission up to 17 years.

Forty-six of the patients were admitted less than 5 years ago 8 in group I, 20 in group II, and 18 in group III.

Five of the 8 patients in group I are free from the disease since the time of their original treatment 1 died from intercurrent disease after being clinically well for over 2 years 1 was clinically well for 4 years when there was a local recurrence which is now undergoing treatment and 1 patient died from extension of the local lesion and metastases in 1 year (see Table I)

Two of the 20 patients in group II are free from the disease for over 2 years since the time of original treatment. Four of the patients are living for from 2 months to 3 years 11 months from the time of admission 2 of these are free from local recurrence for 2 months and 9 months, respectively, although the metastases in the groins are still palpable, 1 patient has been having palliation for over 3 years but the lesion is now progressing and the fourth patient has been free from the disease for 4 and 5 month periods but is now undergoing treatment for her third local recurrence. One patient who died 4 years after admission was free from the disease for 2 years when there was a local recurrence which progressed and caused death. The 13 remaining cases in this group died in from a few months to 3 years (see Table II.)

Four of the 18 patients in group III are free from the disease since the time of our original treatment 1 for 3 years and 9 months, and the 3 others for 4 months to 6 months. Three patients are living at the present time One was free from the disease for 2 years 6 months but now has large

TABLE III—RESULTS OF TREATMENT IN GROUP III

Admitted and treated 5 or more years ago	100
Free from disease—	22
Living over 17 years—free from disease 9 years, 7 months	
Local recurrence treated again free from disease 1 year	
then recurrence which responded to treatment and patient	
now well for 4 years	
Well 6 years	
Deaths—	
Less than 1 year	
1 to 2 years	
2 to 3 years	
6 to 7 years—(free from disease 4 years, 6 months) (see 11)	
recurrence and death	
Lost trace of	
Not treated	
Admitted and treated less than 5 years ago	
Free from disease following original treatment—	
3 years, 6 months	
6 months	
5 months	
4 months	
Living July 1931—	
Lived 5 years free from disease now 3 years, 6 months	
dissection, has large metastases in groins and	
recurrence	
Lived for 1 year 3 months following treatment—	
remained healed but recurred and is progressing	
Lived for 5 months, progressively worse	
Deaths—	
Less than 1 year	
Local lesion well at time of death	
1 to 2 years	
2 to 3 years	
Local lesion well at time of death	
1 to 2 years, with local lesion well at time	
Not observed since treatment	
Not treated	

metastases in the groins and a local recurrence, the 3 other patients are living for 5 months and 1 year 3 months, respectively, but the disease is progressing. Nine patients died in from a few months to 4 years. 1 was not treated and 1 has not been observed since treatment (see Table III).

#### CONCLUSION

1. Cancer of the vulva is a very malignant disease and prone to recur after apparent cure.

2. The only hope of eradicating cancer of the vulva is by its early recognition and radical destruction by coagulation plus heavily filtered irradiation.

3. Where the disease apparently was local, 43 per cent lived 5 years or more. 31.5 per cent were free from disease for a period of 5 years or more.

4. Healings of 5 years are very exceptional if there are metastases in the groins.

5. Radical treatment of early leucoplasic vulvitis and kraurosis is important in the prevention of cancer of the vulva.

6. Thirteen of the 72 cases admitted and treated 5 or more years ago, have lived over 5 years, or 18 per cent and 8 of them are free from the disease or 11 per cent.

#### BIBLIOGRAPHY

- BIRNIE, ELIZ. Personal communication.  
 BUCKNER, L. v. Die Radiumtherapie des Vagino-carcinoms. Strahlentherapie, 1925-1926, xxxi, 713-719.  
 CADRE, STAMFORD. Radium Treatment of Cancer. New York: William Wood & Co., 1926.  
 CLARK, J. G., and NORMAN, C. C. Radium in Gynecology. Philadelphia: J. B. Lippincott Co. 1927.  
 DELPORE, F., and CADRE, J. Le traitement radio-chirurgical des epitheliomas de la vulve. La Cancer 1925, pp. 61-75.  
 EWTING, JAMES. Neoplastic Diseases. pp. 604-606. Philadelphia: W. B. Saunders Co. 1928.  
 GRAVER, W. P. and SMITH, G. V. Kraurosis Vulvae, 1929, xxi, No. 15 April.  
 REICHENBERGER, C. B. Primary epithelioma of the vulva. Ann. Surg. 1929, lxxviii, 709-730.  
 SCHREIBER, BERNARD F. Treatment of epithelioma of the penis, based on a study of sixty cases. Radiology 1929, xiii, 353.  
 SCHULTZ, K. Zur Kasuistik und Statistik des Vulvacarcinoms. Zentralbl. f. Gynæk., 1923, p. 2564. Abstracted in Internat. Abstr. Surg. 1923, lvi, 25.  
 STOUT, ARTHUR P. Human Cancer. p. 383. Philadelphia. Lea and Febiger 1922.  
 TAYLOR, M. Clinical experience with carcinoma of the vulva. Strahlentherapie, 1931, xli, 44-49.  
 TAUBER, Fred J. Leucoplasic vulvitis and cancer of the vulva. Am. J. Obst. & Gynec., 1929, xviii, 472-503.  
 WRIGHT, OTIS B. Melanoma of the labia. Western J. Surg. Obst. & Gynec., 1931, February.

## ENTEROGENOUS CYSTS

## REPORT OF TWO CASES ASSOCIATED WITH THE RECTUM

SAMUEL McLANAHAN M.D. AND HARVEY B. STONE, M.D. F.A.C.S. BALTIMORE, MARYLAND  
From the Surgical Service of The Union Memorial Hospital

ENTEROGENOUS or enteric cysts of true developmental origin have been described as occurring along every portion of the alimentary tract. They are of peculiar interest not only because of their rarity, but also because of the problem they present in clinical diagnosis and the speculation they stimulate as to their origin. The majority of reported cases have been in the ileocecal region where their development has been satisfactorily explained by the presence there of the remnant of the vitelline duct, which remnant more often appears as a Meckel's diverticulum (6). Haggard and Drennen have recently published descriptions of interesting ileocecal cysts. Even more striking are the mediastinal cysts, such as that in the child presented by Poncher and Milles. Among other authors Salvin has described a large retroperitoneal cyst of intestinal origin, and it must of necessity fall into this same group. The retroperitoneal enterogenous cysts, however, are to be distinguished from those of urogenital and lymphatic origin lying in the same region. The location and histological character of the cysts in the 2 cases we are about to report point to their origin from the rectum and stamp them as unusually rare tumors. Evans in his thorough going and exhaustive treatise on these anomalies cites a case of a very long diverticulum of the sigmoid, but does not refer to any cyst of the rectum. Petit de la Villéon presented a child of 2 years from whom he had removed a cyst embedded in the wall of the rectum. As has so frequently been the case this child also exhibited other congenital malformations.

Histologically the structure of such cysts is distinctly enteric. Indeed, a trained observer upon examining a section of cyst wall may be unable to distinguish it from normal intestine. Ewing, however, has emphasized the great variation which is possible in the microscopic appearance, a variation only limited by the actual elements of intestinal structure. Thus the section may contain smooth muscle, lymphoid tissue and mucosa, the latter composed of cylindrical cuboidal or stratified epithelium. The lining may be flat or there may be marked papillary proliferation. This great variety in the lining may

in some instances be accounted for by intracystic tension and in others by inflammation or lack of epithelial differentiation.

Many writers, especially Evans have placed emphasis upon the great prevalence of diverticula in the gut during early life. The epithelial origin of these diverticula in pig, rabbit, and human embryos has been well described in the classic paper of Lewis and Thyny, published 25 years ago. Should one of these epithelial buds lose its communication with the lumen, a potential cyst is formed. Hence the origin of the enterogenous cysts is thought to be in these small diverticula, and it becomes easy to understand that such cysts and diverticula may in reality be different phases of the same process. Following the same line of reasoning it is not difficult to explain the location of a cyst in the intestinal wall, be it submucosal, intermuscular, or subserous. In addition, the tumor may lie at any point in the gut periphery, antimesenteric, mesenteric, or at an intervening site. Many of these cysts are actually found lying between the folds of the mesentery.

Two cases are presented herewith which serve to illustrate well the clinical and pathological features of enterogenous cysts associated with the rectum and at the same time to emphasize certain contrasts in their characteristics.

## CASE REPORTS

CASE 1. E. A. C. a white woman, married aged 48 years, was admitted to the Union Memorial Hospital July 9, 1923 complaining of a lump in her rectum. Eight years previously she had had an appendectomy. Two years previously she had begun to lose weight, although there were no symptoms beyond occasional attacks of indigestion. Eight months before admission she had for the first time experienced a sense of fullness in her rectum which frequently recurred. During the latter part of this period a lump would occasionally project through the anus, it was easily replaced. There had been no bleeding nor had constipation been a feature. She was told by her family physician that she had cancer. Physical examination was negative except for the local condition. The rectal sphincter tone was good. There were no external or internal hemorrhoids. Digital examination revealed a small cystic mass lying about 2 inches within the anal orifice and situated between the posterior wall of the rectum and the coccyx. The mass was about the size of a walnut, was tensely fluctuant freely movable, and not tender. The mucosa over it was intact and there was no bleeding caused by the examination. A diagnosis of a benign cystic tumor was made.



Fig.

Fig. Section through cyst wall in Case 1 showing atrophic type of mucosa.



Fig. 2.

Fig. Section through cyst wall in Case 2. The similarity to normal intestinal structure is to be noted.

**Operation.** Under ether anesthesia, operation was carried out by Dr. Stone. An incision was made posterior to the anus and a multilocular thin-walled cyst identified. In order to obtain better exposure, the incision was extended and the coccyx removed. The cyst was then dissected away from the posterior rectal wall to which it was closely attached. The wound was closed in layers with drainage.

There was moderate pain following the operation and some infection in the wound. However, it slowly but steadily closed, and on August 13, 1933, the patient was discharged as well, with the wound completely healed.

**Pathological report.** Gross description. The gross specimen is a collapsed cyst, irregular in shape, measuring approximately 3 centimeters in diameter. The outer surface is rough and there are mucous fibers attached at various points. The wall of the cyst is thin and the interior is multilocular. The lining is shiny and is covered with a gelatinous material.

**Microscopic description.** The sections through the cyst wall show elongated folds composed of mucosa and submucosa within the lumen of the cyst. There is a definite atrophy of the mucosa characterized by fibrous underlying hyaline degeneration. The epithelium is tall and columnar, of a mucous-secreting type. The submucosa is composed of a loose areolar connective tissue. The outer part of the cyst wall is composed of longitudinal and circular muscular layers covered by a layer of serosa. There is no evidence of any inflammatory process.

**Diagnosis.** enteric cyst

**CASE 3.** Baby J. W. J. male, aged 1 month, was admitted to the Union Memorial Hospital on January 30, 1932, with the complaint of vomiting and constipation. At birth he had weighed 8 pounds, 1 ounce, delivery had been spontaneous. There had always been a tendency toward constipation. For the last week he had lost weight, refused feedings, and vomited occasionally. There had been no bowel movement for 24 hours. Examination revealed a well-nourished baby weighing 9 pounds, 6 ounces. The abdomen was soft; there were no masses nor evidence of visible peristalsis. The rectal sphincter was relaxed, and there was a mass covered with rectal mucous membrane projecting partially through the anus.

On digital examination, the lower portion of the projecting tumor could be outlined as the finger passed around it. Above, however, it appeared to fill the rectum, and the examining finger could not readily pass it. There was apparently complete obstruction. It was concluded that we were dealing with an intussusception, and that the projecting mass was the intussusceptum. Immediate operation was advised.

**Operation.** Under ether anesthesia, laparotomy was performed by Dr. McLanahan. The bladder dilated to within 2 centimeters of the umbilicus, was encountered, and it was necessary to aspirate its contents before proceeding. Exploration of the abdominal cavity failed to reveal any evidence of intussusception. Deep in the pelvis, however, was a fluctuant mass, extraperitoneal and somewhat larger than a golf ball, pressing upon the rectum and the neck of the bladder. This tumor was inaccessible from the abdomen. The wound was quickly closed in layers and the child returned to the ward in fair condition.

The following day, in an effort to relieve the pressure, an aspirating needle was introduced into the mass, entering the skin at a point 1 inch to the right of the posterior margin of the anus. Twenty-five cubic centimeters of cloudy fluid were withdrawn. This fluid contained occasional red blood cells and lymphocytes, culture was negative. During the succeeding month, the contents of the cyst were aspirated five more times, and each time about 25 cubic centimeters were removed, and each time the obstruction was temporarily relieved. Meanwhile, the infant continued to gain weight and improve.

**Operation.** On March 5, 1932, an incision was made to the right of the rectum directly over the cyst, which now when distended could be seen outlined in the perineum. The cyst wall was readily identified, and there was no great difficulty in dissecting it from the surrounding structures. It lay in close proximity to the rectal wall but did not appear actually to involve it. The wound was closed with drainage.

The wound drained for a time with some local infection, but gradually healed and the child was discharged on March 23, 1932, as well. The child has continued well and is developing normally.

**Pathological report.** Gross description. The gross specimen is that of a collapsed cyst which, when dilated, would approximately measure about 4 centimeters in diameter. The serous surface is of a greyish color and resembles an intestinal wall. There is considerable irregularity in the thickness of the wall. The lining of the cyst is soft and covered with a gelatin-like substance.

**Microscopic description.** Sections show a well defined mucosa lined with columnar epithelium. The epithelial cells in some areas are of the tall, columnar mucous-secreting type. There is a definite muscularis mucosae and submucous layer. The outer wall, which shows considerable hypertrophy is composed of two distinct circular and longitudinal layers covered by serosa. There is no evidence of any inflammatory process. The histological appearance of the microscopic sections is identical to that of an enteric theme.

**Diagnosis.** enteric cyst.

The two cases reported show a marked discrepancy in age, and thereby illustrate an interesting feature in the clinical history of such tumors. The one case is an infant who almost certainly must have been born with a sizeable cyst, and the other an adult who had no symptoms until 47 years of age. The mechanical pressure of an enterogenous cyst especially when it is located within the peritoneal cavity, may lead to obscure abdominal colic, and in many instances may bring about a true intestinal obstruction. Particularly is this true of the ileocecal cysts which time and again have initiated an intussusception. Intestinal bleeding has often been attributed to the cysts, but probably occurs less often than in the case of the diverticula. In each case there was a failure to diagnose accurately the true condition in the one case a diagnosis of malignancy having been made by the original examiner and in the other a diagnosis of intussusception by the pediatrician and surgeon.

Histologically, the cysts are both characteristic of rectal structures. However, in each instance a variety in the microscopic appearances is seen in the slide. At places the wall is thick, and at others thin. The epithelium especially shows a marked variation, in some areas proliferation and in others atrophy, while both columnar and cuboidal cells may be seen. The two sections shown (Figs. 1 and 2) illustrate contrasting fields.

The treatment has been satisfactory, depending finally upon the simple excision of a benign cyst in each instance. Such excision should al-

ways be carried out when an enterogenous cyst is suspected.

#### SUMMARY

Enterogenous or enteric cysts may occur along any portion of the gastro-intestinal tract, but are most common in the ileocecal region and least common in the rectal area.

Histologically they are composed of intestinal elements which may show great variations. Their origin is usually traced to the small diverticula of the gut occurring in fetal life and it is thought that the diverticula and cysts appearing later are in reality different phases of the same process. Such an origin aids in explaining the location of the cysts with respect to the intestinal wall. Two cases of enteric cysts are reported, one in an adult of 48 years and one in an infant of 1 month. In each case the tumor lay in close association with the rectum and was successfully removed by the perineal route. Complete recovery ensued in each case. The microscopic sections showed the typical rectal appearance with expected variations in the epithelial structure. The possibility of an enterogenous cyst should be borne in mind in considering the differential diagnosis of a rare abdominal or rectal tumor and excision should be carried out when its presence is suspected.

We wish to acknowledge our indebtedness to Dr. Walter C. Merkel for the pathological reports.

#### REFERENCES

1. DRENNEN E. Ileocecal cysts. Arch. Surg. 1931 xxi, 106.
2. EVANS, A. Developmental enterogenous cysts and diverticula. Brit. J. Surg. 1929 xvii, 34-83.
3. EWING, JAMES. Neoplastic Diseases. p. 1030. Philadelphia and London W. B. Saunders Co. 1931.
4. HAGGARD W. D. Enterogenous cyst of ileum causing obstruction in infant. Surg. Clin. N. America, 1930 x 713-717.
5. LEWIS, F. J., and THYNG F. W. The regular occurrence of intestinal diverticula in embryos of pig, rabbit, and man. Am. J. Anat. 1907 1908, vii, 505.
6. MEXERL, J. F. Darmkrankheiten. Handbuch der pathologischen Anatomie. Vol. 1 p. 553. Leipzig C. H. Reclam, 1812.
7. PETIT DE LA VILLON M. Kyste congénital du Rectum. Bull. et mém. Soc. de méd. et chir. de Bordeaux 1915 p. 39.
8. PONCHER H. G. and MILLER G. Cysts and diverticula of intestinal origin. Am. J. Dis. Child. 1933 xiv 1064-1078.
9. SALVIN A. A. Retroperitoneal cyst. Med. J. Rec., 1928, cxvii, 256-259.



INDICATIONS FOR OPERATION IN GASTRIC SYPHILIS<sup>1</sup>

JAMES T. PRIESTLEY, M.D. F.A.C.S. AND WALTER WALTERS, M.D. F.A.C.S.

ROCHESTER, MINNESOTA

Division of Surgery The Mayo Clinic

THE relative rarity of demonstrable gastric syphilis and the diagnostic difficulties which this condition may present, contribute to the many interesting problems involved in the proper care of the patient with a definite gastric lesion associated with serologic evidence of syphilis. Gastric syphilis was found by Kirklin and Eusterman only three times in every thousand cases of syphilis. The persistent or recurring dyspepsia of syphilitic patients was found usually to be caused by neurosyphilis, or in the presence of an organic gastric or duodenal lesion, by carcinoma or gastric or duodenal ulcer. The question of primary importance which arises in each case is whether the gastric deformity visualized roentgenographically is actually of syphilitic origin or on the contrary a malignant growth occurring in a patient with syphilis. The importance of an accurate differential diagnosis in such cases is accentuated by the fact that the treatment of one is primarily surgical and of the other primarily medical. Although in some cases there are definite clinical and roentgenological criteria characteristic of syphilis of the stomach, in others it may be difficult to make a positive diagnosis of this condition without surgical exploration. A therapeutic test with antisyphilitic treatment, unfortunately necessitates at least several weeks for trial and an undesirable delay if the lesion prove malignant.

Eusterman's outline of the typical features of gastric syphilis has greatly facilitated its clinical recognition. He emphasized that it occurs usually during the second to the fourth decade of life. The gastric symptoms are marked and progressive with an average duration of 2 years, and usually absence of an epigastric mass, retention, nausea, anemia, cachexia and bleeding. In contrast, gastric carcinoma is more common among older persons. Usually the symptoms are less prolonged, there is often a palpable mass, and anemia, cachexia and bleeding may develop. If a palpable mass is present and the value for hemoglobin is relatively high, gastric syphilis, rather than carcinoma, is suggested.

The roentgenological evidence of gastric syphilis described by Carman and Kirklin, although not absolutely pathognomonic in every case usually aids materially in the differential diagnosis. Characteristically in these cases, there is a circumscribed or diffuse concentric involvement converting the affected "segment into a narrow tube



Fig. 1. Portion of stomach removed, syphilitic gastritis and shallow serpiginous ulcers may be noted. Case 1.



Fig. 2. Gross appearance (upper) and cross section (lower) of liver: extreme atrophy of the right lobe and irregular enlargement of left lobe may be noted. Case 6.

with a relatively smooth lumen of uniform caliber "in which there is no intrusion into the lumen of a distinct growth. There is usually some degree of 'stiffening, lessened mobility, and absence of peristalsis.'" The roentgenological abnormalities may appear more extensive than the general condition of the patient would suggest, if the abnormalities were caused by a malignant growth. Moore and Aurelius stated that in 70 per cent of the cases studied the lesion was prepyloric and concentric in 22 per cent the lesion was of the dumb-bell or hourglass outline and in 8 per cent involvement was diffuse. Despite these supposed distinguishing features the clinical diagnosis of gastric syphilis remains doubtful in some cases.

At the first examination cases in which there is serological evidence of syphilis associated with a definite gastric lesion may be classified in three main groups depending on the therapeutic indications and method of treatment: (1) cases in which the diagnosis of gastric syphilis can be established with a high degree of accuracy according to the clinical and roentgenological criteria outlined and cases in which all the clinical and roentgenological evidences of an inoperable gastric lesion are present, regardless of whether this appears to be syphilitic or malignant; (2) cases in which serological evidence of syphilis is incidentally associated with an operable, malignant gastric tumor or a non-specific inflammatory gastric lesion which definitely requires operation because of obstruction, perforation, the possibility of malignancy or some other reason which renders medical cure insufficient; and (3) cases in which there is serological evidence of syphilis associated with a definite gastric lesion the clinical diagnosis of which is indeterminate between malignancy and syphilis. Depending on the conditions surrounding the individual case, combined surgical and medical treatment or medical treatment alone will be indicated. In brief cases in group 1 are usually primarily medical, whereas in those of groups 2 and 3 exploration should be carried out. Five illustrative cases in which we operated have been selected for presentation.

Cases classified in the first part of group 1 can be diagnosed with considerable accuracy because they present all the characteristic clinical and roentgenological criteria of gastric syphilis. Consequently, antisyphilitic treatment should be instituted unless the lesion is causing marked obstruction, in which event operation for its relief may be necessary. As a rule, however antisyphilitic treatment affords remarkable results and operation is indicated only when the lesion does not heal, or when during the course of healing

marked constriction results in obstruction. It is interesting in this connection that Eusterman found no improvement in 10 per cent of the 93 cases of gastric syphilis in which antisyphilitic treatment was given, although in 79 per cent complete cure or very great relief was obtained. In the 17 per cent remaining some improvement was noted. In those cases classified in the second part of group 1 in which an unusually extensive roentgenological deformity was present, or one was so situated and so fixed to surrounding structures that it appeared inoperable even although it suggested malignancy, gratifying results may be obtained from vigorous antisyphilitic treatment. Occasionally even a patient with a malignant gastric lesion may show some temporary improvement due to the non specific effect of antisyphilitic treatment.

#### REPORT OF CASES

**GROUP 1 CASE 1:** Clinical diagnosis of gastric syphilis. Failure of patient to improve under a brief antisyphilitic regimen.

A woman, aged 61 years, registered at the clinic October 31, 1932, with the complaint of indigestion of 1 year's duration. This was characterized by bloating, belching, and epigastric soreness. There was no nausea or vomiting. The patient was unable to eat an average size meal, despite a good appetite because the stomach "filled up so quick ly." There was a loss of 30 pounds during the last year.

Physical examination was essentially negative except for the obvious loss of weight and moderate epigastric tenderness. The Kline and Kahn reactions were positive. Analysis of gastric content gave evidence of no free hydrochloric acid and a low total acidity and one specimen contained a small amount of blood. Roentgenological examination revealed an ulcerating lesion of the middle third of the stomach somewhat suggestive of carcinoma. Clinically the diagnosis of gastric syphilis was considered probable and it was thought justifiable to give the patient a short course of antisyphilitic treatment, rather than advise immediate exploration. Arphenamine, iodides, and bismuth were employed for 2 weeks with but slight improvement in symptoms and no roentgenological evidence of change in the gastric lesion, and so operation was advised.

November 18, 1932, partial gastrectomy of the posterior Pólya type was performed for an obstructing tumor in the lower third of the stomach. The tumor was soft and felt somewhat like a papillary carcinoma, but it was impossible to be certain of its exact nature at that time. Because of the indeterminate diagnosis, the failure to respond to medical treatment, and the readily resectable nature of the lesion, its removal seemed definitely indicated. Some hepatic cirrhosis was present. Pathological study revealed syphilitic gastritis with multiple shallow serpiginous ulcers of the submucosa thickened, and marked perivascular infiltration of lymphocytes and plasma cells (Fig. 1).

Convalescence was uneventful. Six months after the operation, the patient stated that she had gained weight, felt well and was able to return to her former duties.

A case of this type introduces the question of how long antisyphilitic treatment should be given before it is decided to be ineffectual. The opti

imum length of time will vary somewhat, depending on the circumstances involved in each case. As a rule, however, definite improvement is noticeable in 2 or 3 weeks if antisyphilitic treatment ultimately is to prove satisfactory. Occasionally when complete or partial healing of a syphilitic gastric lesion occurs, under the influence of antisyphilitic treatment obstruction may result because of constricting fibrotic changes, which develop during the process of healing. In these cases operation may be required because of symptoms of obstruction.

**GROUP 1. CASE 2.** Disappearance of apparently inoperable gastric lesion under antisyphilitic treatment.

A woman, aged 44 years, came to the clinic February 20, 1933, complaining of persistent, dull, epigastric pain of 4 months' duration. The pain often radiated to the back or right lower abdominal quadrant, and was likely to be more severe when the stomach was empty. There was some associated bloating, nausea, and occasional vomiting which ingestion of alkaline powders failed to relieve. The patient lost 3 pounds.

Physical examination was negative except for moderate tenderness and an indefinite sense of resistance above and slightly to the right of the umbilicus. The Kline and Kahn tests both gave strongly positive reactions. Analysis of gastric content revealed an absence of free hydrochloric acid and a low total acidity; there was no retension. Roentgenographic examination of the stomach revealed an extensive lesion of the cardia and fundus, interpreted as probably an inoperable carcinoma. Clinically it seemed as though a carcinoma of this size would have produced a greater systemic effect and possibly have formed a palpable mass. For these reasons and because of the inaccessibility of the lesion, antisyphilitic treatment was begun March 1, 1933. Roentgenological examination 8 days later did not give evidence of change, but April 3, it disclosed an apparently normal stomach without visible evidence of deformity. At this time the patient felt well, had gained weight and had no gastric symptoms. The original roentgenographic interpretation of the gastric deformity as a malignant lesion apparently was erroneous, as shown by prompt disappearance of lesion under antisyphilitic treatment.

In group 2, if the malignant or non-specific inflammatory lesion definitely requires operation and is incidentally associated with serological evidence of syphilis, prompt surgical treatment should be instituted before antisyphilitic treatment is tried. As mentioned previously the mere finding of a positive Wassermann reaction in cases in which the complaint primarily is of gastric symptoms, is no indication of the true nature of any coexisting gastric lesion, as in the majority of cases this will not prove to be of syphilitic origin. These cases are often encountered, as the syphilitic patient may have any type of gastric change as readily as the non-syphilitic patient. The history, clinical examination, and roentgenological evidence aid in determining the character of the gastric change. Antisyphilitic treatment should be instituted as soon as convalescence permits.

In group 3 systemic syphilis is associated with indeterminate gastric change. These cases are of particular interest as the treatment varies with the extent and situation of the lesion and the accuracy of the diagnosis. If it is impossible to distinguish clinically with any degree of accuracy between gastric syphilis and carcinoma, when the lesion is easily resectable and situated in the pyloric portion of the stomach, abdominal exploration is definitely indicated.

The recognition of gastric syphilis at the time of exploration often affords some difficulty and depends largely on the surgeon's familiarity with the gross characteristics of this disease. Unfortunately microscopic studies at the time of operation are of little value except to exclude malignancy. Because of these facts, the recent contribution of Meyer and Singer is of particular value in emphasizing the diagnostic features of gastric syphilis as seen by the surgeon. The differential diagnosis is usually between carcinoma and syphilis. The syphilitic lesion appears inflammatory. The walls of the stomach are diffusely thickened, somewhat infected, and not associated with a firm, localized lesion having the feel of malignancy. Meyer and Singer emphasize the disparity between the size of the roentgenological defect and the actual anatomical change palpable in cases of gastric syphilis. The former frequently indicates a large deforming lesion which is not demonstrable at the time of exploration. They believe that the infiltrate found in these cases, chiefly in the submucosa, accounts for the extensive roentgenological abnormalities often observed.

In some cases there are other visceral lesions suggestive of syphilis associated with pathological changes in the stomach. If the diagnosis still remains in doubt at the time of exploration, the lesion should be resected in order to avoid the possible misfortune of leaving a malignant growth. Likewise, if it is thought that the lesion is syphilitic and definite obstruction exists, or if the lesion is such that this might occur following antisyphilitic treatment, operation is advisable. If on the contrary at the time of exploration a definite and extensive syphilitic lesion is found in the stomach possibly associated with marked syphilitic changes in the liver or other organs, it is best to close the wound and subsequently to institute antisyphilitic treatment.

**GROUP 3. CASE 3.** Indeterminate clinical diagnosis. Gastric endobothelium removed from syphilitic patient.

A man, aged 55 years, came to the clinic September 10, 1930, complaining of generalized weakness of 5 months' duration. One month previously cramps of dark red blood had occurred; otherwise a history of stomach trouble was not elicited.

Physical examination disclosed slight epigastric tenderness. The Kline test gave a positive reaction. Analysis of gastric content revealed that the acids were normal, but there was some evidence of retention. Two roentgenological examinations of the stomach did not reveal a recognizable lesion. The clinical diagnosis, therefore, remained in doubt. However, with the definite history of gastric hemorrhage, which recurred during the course of examination, exploration seemed indicated as a small, high lying, malignant lesion might be present. The patient was placed in a hospital for a period of pre-operative preparation as the concentration of haemoglobin was only 50 per cent (Dare) on admission. After fluids had been given liberally and four transfusions of blood, the patient's condition improved and exploration was performed.

September 23, 1930, a partial gastrectomy of the posterior Polya type was carried out. A mass about 7 by 6 by 6 centimeters was found on the lesser curvature at the junction of the upper and middle thirds of the stomach. There was an ulcer on the anterior wall of the duodenum, about 1 centimeter in diameter. At exploration the tumor was thought to be a sarcoma. As there was no demonstrable nodal involvement and because the tumor could be removed, extirpation of the lesion seemed advisable. Approximately three-fourths of the stomach was resected. Pathological examination of the tissue revealed a malignant endothelioma arising from the peritoneal surface of the stomach. The tumor which involved the musculature of the gastric wall, had also produced a small area of ulceration on the mucosa. Antisyphilitic treatment was instituted when the patient was dismissed from the hospital.

Convalescence was without event. The patient's general condition was excellent on dismissal from observation, and 1 year after operation, he was in good health.

GROUP 3, CASE 4. Indeterminate clinical and surgical diagnosis. Resection of a probable syphilitic gastric lesion.

A man, aged 45 years, came to the clinic August 19, 1931 complaining of stomach trouble of 8 months duration, characterized by anorexia, epigastric fullness, and occasional vomiting. The symptoms were persistent but not severe. There was a loss of 15 pounds. A history of a peptic lesion in 1929 was elicited.

Physical examination was essentially negative. Kline and Kahn tests gave negative results. Analysis of gastric content revealed no free hydrochloric acid and only a low total acidity and a moderate degree of retention. Roentgenological examination disclosed an annular lesion at the outlet of the stomach presenting the characteristics of syphilis. As there was no clinical evidence of syphilis and the possibility of gastric malignancy could not be absolutely excluded exploration was advised.

August 25, 1931, resection of the posterior Polya type was performed for an obstructing mass at the lower end of the stomach. On gross examination it was impossible to determine with any degree of accuracy whether the lesion was inflammatory or malignant. Because of this and because of the mobility of the lesion, resection was performed in the usual manner removing the lower half of the stomach. Examination by pathologists revealed probable syphilitic gastritis with perivascular infiltration of lymphocytes and plasma cells. Convalescence was uneventful.

The patient improved greatly after operation. When last heard from, 9 months later he was in fair general health but occasionally had some digestive disturbances.

GROUP 3, CASE 5. Indeterminate clinical diagnosis. Gastric syphilis diagnosed by surgical exploration.

A man, aged 51 years, came to the clinic, April 4, 1933, complaining of fatigue and loss of 15 pounds in the last 6 months. For the previous 3 months constant epigastric distress had been present which was unrelieved by ingestion

of alkaline powders. Although the appetite remained fairly good, an average size meal could not be eaten because of epigastric fullness. Syphilitic infection was denied.

Physical examination revealed a moderately enlarged and irregular liver. The Kline and Kahn tests gave positive reactions. Fractional analysis of gastric content revealed absence of free hydrochloric acid, low total acidity and a small amount of fresh blood. Roentgenographic examination of the stomach disclosed a deformity in the pyloric region, thought to be caused by an operable carcinoma. There was also an area of irregularity in the middle segment of the greater curvature which suggested the possibility of a second lesion.

The absence of any syphilitic stigmata, the age of the patient, the irregularly enlarged liver, the short, persistent course of the symptoms, the detection of blood on analysis of gastric content, and the roentgenographic findings, all suggested the probability of gastric carcinoma, rather than a syphilitic lesion. The latter diagnosis could not, however, be definitely excluded. Under the circumstances, exploration seemed indicated.

At operation April 7, 1933, the lower two-thirds of the stomach was found to be involved in an oedematous infiltrative process which had the appearance and feeling of a diffuse inflammatory lesion. There was some irregularity palpable on the posterior wall and greater curvature. The serosal surface of the stomach was oedematous and vascular. An enlarged gland in the gastroduodenal omentum was removed for diagnostic purposes and reported to be inflammatory. The liver presented a remarkable example of tertiary syphilis for which the name *hepar lobatum* is most applicable. The left lobe was contracted, forming globular shaped masses, about 5 centimeters in diameter and the right lobe was deformed with multiple indentations and nodules. The surface of the liver was covered with a plastic fibrous exudate and presented a mottled cherry red and mulberry granular appearance. Further exploration was negative except for the presence of a small amount of free fluid within the abdomen. It was thought that the gastric and hepatic lesions undoubtedly were the results of tertiary syphilis. The operation was concluded as an exploration.

Immediate convalescence was without event. Mild antisyphilitic treatment, with mercury only was instituted because of the hepatic involvement. Frequent roentgenological examinations of the stomach were advised. Unfortunately antisyphilitic treatment for a period of 7 weeks did not relieve the patient, and he returned recently complaining of excessive vomiting. Clinical and roentgenological evidence corroborated the diagnosis of pyloric obstruction. Following a few days preliminary preparation, operation was performed July 4, 1933 at which time a posterior gastro-enteric stoma was made for obstructing sclerotic, syphilitic gastritis situated in the pyloric region. There was marked ascites at the time of operation, and the parietal peritoneum and viscera appeared inflamed. The liver was still markedly deformed and seemed a trifle smaller than it did at the time of the first operation. The stomach was greatly dilated. The diffuse nature of the gastric lesion noted at the previous operation had changed to a more localized, obstructing, inflammatory condition in the distal half of the stomach. There was no discernible evidence of a malignant lesion. Evidence of hepatic decompensation developed in this case before dismissal, characterized by the development of abdominal ascites requiring paracentesis. In fact, paracentesis was necessary once or twice after the patient returned home but recently he has improved remarkably. When last heard from, 5 months following operation, the patient was gaining weight and was in excellent general health. His appetite was good and he made no complaints of digestive trouble. He was con-

thod with the injections of mercury and with the taking of iodides by mouth.

**GROUP 3, CASE 6.** Exploration for suspected gastric tumor. Syphilitic hepatitis and probable syphilitic gastritis disclosed.

A man, aged 57 years, registered at the clinic November 27, 1933, complaining of intermittent attacks of epigastric distress following meals for a number of years. Hematemesis occurred on three different occasions. In the last few months he had lost some strength and 5 pounds.

Physical examination gave essentially negative results except that an irregular mass was palpable in the epigastrium and left upper part of the abdomen. The concentration of hemoglobin was 24 per cent and erythrocytes numbered only 1,760,000 per cubic millimeter of blood. The Kline and Kahn tests were both strongly positive. Roentgenographic examination of the stomach, November 28, 1933, revealed slight cardiospasm and the presence of food in the stomach. The second examination, November 30, 1933, disclosed what appeared to be a polypoid growth in the distal two-thirds of the stomach, which was thought to be benign and operable, although the examination was not entirely satisfactory to the roentgenologist.

The patient was hospitalized November 28, 1933, and received two blood transfusions and one injection of penicillin before operation, which was performed December 6, 1933. On exploration, the mass that previously had been palpated was found to be caused by extensive syphilitic hepatitis. The left lobe of the liver was greatly enlarged and irregular in outline, and the right lobe was markedly atrophied. The entire liver presented a purplish-brown appearance and the lobular deformity characteristic of syphilis. The surface of the liver was covered by fibrous adhesions between the dome and the parietal peritoneum above it. There was no evidence of a primary gastric lesion, but mild, diffuse gastritis, evidenced by petechial hemorrhages in the subperitoneal coat, extended throughout the entire organ. The spleen was moderately enlarged and was adherent to the peritoneum. The anterior wall of the stomach was incised in order to permit inspection from within, but a tumor was not disclosed. A specimen for biopsy was removed from the stomach and one from the liver. With the hope of preventing subsequent hematemeses, the left coronary vein was divided and ligated.

The pathologists reported chronic hepatitis with interlobular fibrosis and lymphocytic infiltration. There was evidence of degeneration and regeneration of hepatic cells, and the picture presented was considered to be not inconsistent with that of hepatic lobatum. A specimen from the gastric wall disclosed an inflammatory reaction.

Postoperative convalescence was fairly satisfactory until December 10, 1933, when patient suddenly became weak, and large, tarry stools were passed. Despite all types of supportive treatment, he failed rapidly, and death ensued.

Postmortem examination disclosed a large, recent gastrointestinal hemorrhage which apparently arose from esophageal varices. Multiple granules were found in the spleen. There was extensive cirrhosis. As noted at the time of operation, there was atrophy of the right lobe of the liver grade 3, and marked enlargement of the left lobe (Fig. 2). The surface of the liver was nodular and presented many pockered scars. The liver cut with increased resistance, and on the interior were many yellowish nodules and an excessive amount of connective tissue. The remainder of the examination revealed nothing of unusual interest.

#### COMMENTS

**DR. O'LEARY.** If a patient with syphilis has a demonstrable lesion in the stomach, the differen-

tial diagnosis usually includes gastric carcinoma and gastric syphilis. If the roentgenogram reveals the lesion to be situated so that it is operable, it is essential not to delay operation so long that the chance for cure will be lost if carcinoma is present. The therapeutic test for syphilis offers, in many of these cases, a means of distinguishing between gastric carcinoma and gastric syphilis in a comparatively short time. The test is best undertaken with the patient in hospital where arsphenamine can be given weekly and mercury or bismuth daily or less frequently according to the preparations used. Besides recording the weight daily food should be given five or six times a day because of the reduction in the capacity of the stomach. Frequent estimations of the hemoglobin content and erythrocytes may be of aid at the same time bearing in mind that one of the significant clinical findings in gastric syphilis is the relatively normal concentration of hemoglobin and number of erythrocytes in the presence of a gastric lesion accompanied by marked loss of weight. In the presence of a palpable gastric mass, an appreciable decrease in the size of the tumor during the course of the therapeutic test is also significant. The patient with gastric syphilis of the nodular ulcerated or circumscribed types usually improves rapidly under this regimen. Within a few days he is able to eat increasing amounts of food with a steady decrease in discomfort after eating and a sense of increased well being. The weight and hemoglobin content increase steadily. In this type of case interpretation of the therapeutic test is not difficult, and continued treatment results in complete relief of symptoms in a high percentage of cases. Unfortunately all patients with gastric syphilis do not show such phenomenal response because if the process is diffuse and infiltrative, or if the stomach is contracted and fibrotic, considerable difficulty will be experienced in interpreting the results of the therapeutic test. In such cases improvement is slow and decidedly less marked, or if the lesion is of many years standing and fibrosis advanced, there may be no relief of symptoms. The decision to explore in these cases is based on the fact that in the presence of an operable lesion and in the absence of response to antisyphilitic remedies, attempts at surgical cure must not be delayed until lymphatic involvement occurs. However in certain of the cases of this group if the therapeutic test is extended over a period of 4 to 6 weeks, sufficient systemic improvement may occur to warrant the diagnosis of gastric syphilis. The roentgenogram is not of much aid in the interpretation of therapeutic effects because the contracted stom-

achs do not show any change in the deformity following antisyphilitic treatment.

The danger of surgical procedures in cases of gastric syphilis lies in the unnecessary excision of a gummatous gastric lesion, the subsequent extension of the syphilitic process, and the resulting increased gastric deformity. In cases of syphilitic gastritis with fibrosis gastro-enterostomy or partial gastrectomy may give considerable relief. Likewise the opportunity for examination of the liver at the time of operation may give valuable information as to the type and amount of anti-syphilitic treatment permissible, depending on the degree of hepatic involvement.

It is of interest to note the so called non-specific effect which the patient with syphilis and gastric carcinoma may derive from arsphenamine and bismuth or mercury. A slight gain in weight and appetite during the first 2 weeks of a therapeutic test may slightly simulate the effect of treatment. The degree of improvement, however, is temporary and less marked, and not so complete as that observed in cases of gastric syphilis.

DR. EUSTERMAN Surgical contributions concerning a rare type of visceral syphilis, which more frequently simulates malignant lesions of the stomach than any other entity, are highly important and timely. Knowledge concerning gastric syphilis has been greatly extended in the last 15 years, due largely to the collaboration of the clinician, roentgenologist, and syphilologist, in addition to evidence afforded by pathological and bacteriological study of resected material. Yet in spite of these advances one cannot escape the conviction that too often the specific nature of the lesion was not established, or even suspected until after its surgical removal. Speaking generally of a dyspeptic patient in the thirties or early forties presents serological or clinical evidence of systemic syphilis, or both, who is not cachectic or anemic as a rule, and who on further examination has no palpable epigastric mass and no undue retention of gastric content, but who invariably has achlorhydria and a gastric filling defect usually indistinguishable from that of gastric carcinoma, it is highly essential to exclude the syphilitic nature of the gastric lesion. On the other hand an elderly patient with recent onset of gastric disturbances who exhibits variable degrees of cachexia, in association with a palpable mass or gastric retention, or both, invariably harbors a malignant lesion even if frank evidence of coexisting systemic syph-

ilis is at hand. Diagnostic teamwork on the part of the experienced clinician, the surgeon and the syphilologist will successfully disclose the nature of the lesion in the majority of the doubtful cases without in any way militating against the chances for the patient's recovery even though the lesion should eventually prove to be malignant.

Two other factors warrant brief consideration. First, pyloric obstruction or tumor, or a combination of both in the same case is not necessarily an indication for immediate surgical intervention. If these patients are young, the favorable results of antisyphilitic treatment may be as spectacular as in the uncomplicated cases. Undoubtedly the lesions under consideration were not in an advanced stage, as the tumor disappeared promptly and the obstruction was relieved within a short period. But inasmuch as tumefaction and pyloric obstruction, or gastric retention, are three to four times as common in malignant conditions as in gastric syphilis the possibility that the lesion is malignant must always be regarded seriously, especially if the patient is elderly. Second, my own experience is in accord with that of O'Leary, Singer and others that in the more advanced syphilitic lesion the results of antisyphilitic treatment are not appreciable sometimes until after 4 to 6 weeks have elapsed. When the evidence favors the syphilitic nature of the lesion, or if by virtue of its position or extent, as determined roentgenoscopically it is inoperable if malignant such extension of treatment, which is necessary at times seems justified. Concerning the improvement following the use of arsenicals in cases of carcinoma, with which I have never been impressed it must be remembered that there is never any anatomical change for the better in the lesion, which is fundamentally important.

#### BIBLIOGRAPHY

1. CARMAN, R. D. Syphilis of the stomach in its roentgenologic aspects. *Am. J. Syphilis*, 1917, 1, 111-116.
2. EUSTERMAN, G. B. Gastric syphilis, etc. *J. Am. M. Ass.*, 1931, xxvi, 173-179.
3. KIRKLESI, B. R., and EUSTERMAN, G. B. Combined roentgenologic and clinical differential diagnosis of benign and malignant lesions of the stomach. *Am. J. Surg.*, 1935, xv, 468-471.
4. MEYER, K. A., and SINGER, H. A. Syphilis of the stomach. *Arch. Surg.*, 1933, xxvi, 443-464.
5. MOORE, A. B., and AUZELIUS, J. K. Roentgenologic manifestations in eighty-seven cases of gastric syphilis. *Am. J. Roentgenol.*, 1928, xix, 425-430.

## VESICOVAGINAL FISTULA AND TECHNIQUE OF REPAIR

GEORGE W. STEPHENSON, M.D. ROCHESTER, MINNESOTA

*Fellow in Surgery The Mayo Foundation*

AND

JAMES C. MASSON, M.D. F.A.C.S., ROCHESTER, MINNESOTA

*Division of Surgery The Mayo Clinic*

A FISTULA between the vagina and the bladder may arise from any one of four causes. In cases encountered at The Mayo Clinic in the past 3 years, judging from the histories given by the patients, the most common cause has been difficult obstetric deliveries, with forceps. The second cause in order of frequency was some form of pelvic operation, usually hysterectomy the third, advanced carcinoma of the uterine cervix and the fourth cancer of the uterine cervix which had previously been treated with radium. A fifth cause, which might be added is prolonged use of an ill fitting vaginal pessary.

Several competent authorities have denied that the use of forceps, in itself causes injury to the bladder but that the prolonged labor in which it is eventually necessary to use instruments often produces such pressure on the anterior vaginal wall that the blood supply is materially affected. That this may be true is shown by many reports of cases in which the fistulas did not appear until several days after termination of labor. It is difficult to arrive at a close estimate of the frequency with which obstetric procedures cause fistulas, except through examination of material collected in a large obstetric clinic and even such an estimate would be unreliable with respect to the practice of obstetrics in general. In The Mayo Clinic it was thought advisable to use forceps in 309 cases in the past 3 years. In some of these, forceps were applied merely to lift the head over the perineum after episiotomy had been performed. Fistula did not result in any of these cases. Hysterectomy of various types was performed in 1,067 cases in this same period of 3 years, in only one of which a vesicovaginal fistula occurred. This incidence probably cannot be applied generally however for the operations were performed by surgeons who specialize in gynecology.

Of 24 cases of vesicovaginal fistula encountered at the clinic in 1931 and 1932 the condition had followed hysterectomy in 8 cases. Prolonged and difficult labors preceded the appearance of fistula in 7 other cases, and in 7 of the remainder there was carcinoma of the uterine cervix. One of the

fistulas followed an attempt at repair of a congenital anomaly of the base of the bladder and urethra, and one followed vaginal cystostomy for tuberculous cystitis.

The ages of these 24 patients varied from 14 to 76 years, most of them were in the fourth to the sixth decades of life, corresponding to the child bearing age and to the age at which hysterectomy is most often performed. Two of the women were not married both of them were less than 20 years of age when the fistula formed.

Ordinarily diagnosis of vesicovaginal fistula is easy. In addition to the incontinence, which is usually accurately localized by the patient, there is an ammoniacal odor sometimes intermittent fever hematuria, and often excoriation of the vaginal mucous membrane, and sometimes of the adjacent skin. When the internal orifice of the fistula is high in the base of the bladder there may be no leakage of urine for short periods while the patient is standing. If the fistula is small, she may be able to pass appreciable amounts of urine through the urethra. Examination of the vagina through a speculum is usually sufficient, but it occasionally becomes necessary to inject some dye into the bladder so as to distinguish the vaginal opening definitely. When the fistula is small, it is best to have a cystoscopic examination as well, at which time a thread often can be passed through the fistula and left in place to serve as a guide to the surgeon.

Treatment of vesicovaginal fistula in the absence of malignancy is usually surgical. In a few cases, in which the fistula follows delivery, observation for as long as 6 months is justifiable provided improvement is apparent for occasionally this type of fistula closes spontaneously. No attempt at closure should be made until complete involution of all pelvic organs has occurred. Deutschman recently reported 4 cases in which no operative procedure was necessary even though the fistulas in 3 of the cases were rather extensive when first seen. Malignant growths of the uterine cervix which have extended into the base of the bladder and subsequently caused sloughing, with consequent leakage into the vagina, are not amenable to surgical treatment.

Pioneer work on methods of repair of vesicovaginal fistula was done by Sims in the middle years of the last century. Our method of repair whenever possible, is a modification of that proposed by C. H. Mayo in 1916 and later amplified by Judd and by Mayo and Walters. After a thread is passed through the fistula at cystoscopic examination, the patient is sent for operation. With the patient in the lithotomy position, the thread is utilized to draw a silver wire through the fistula to serve as a durable guide during dissection of the tract. The vagina is incised in the transverse direction on each side of a circular cut about the fistula, and the base of the bladder is separated from the anterior vaginal wall. With the wire as a guide, dissection is carried well up toward the mucosa of the bladder, and a purse string suture of No. 00, 20-day, chromic catgut is placed in the muscular layer. The greater part of the fistulous tract is excised, and the vaginal end of the wire is grasped in a blunt haemostat. By making traction on the other end of the wire, the stub of the fistula is inverted into the bladder and the pursestring is pulled tight. Reinforcing sutures, also of chromic catgut, are placed in the longitudinal axis, and the transverse cut in the vaginal wall is closed separately, using interrupted sutures of silkworm gut (Fig. 1). When the two lines of suture can be separated by normal tissue, the chances of permanent closure are good. As a final step, a retention catheter is placed in the bladder, to be left about 10 days. Some authors advise against the use of a catheter, and in cases in which the fistula is in the neck of the bladder and the catheter would be in direct contact with the site of closure it would probably be safer to keep the bladder from becoming distended by careful use of a small glass catheter every 3 hours. In a few cases in which the vaginal approach is impracticable, either because of the position of the fistula or because the vaginal orifice is so small that extensive lateral episiotomy would be necessary for exposure, it is advisable to use a transvesical approach. A complete review of the development and application of this operation and the bibliography has recently been published by Sears. Occasionally, when the fistula is high and the vagina small and narrow, intra abdominal separation of the base of the bladder from the vagina and closure of the two openings separately, may give satisfactory results.

It may be noted that the suture material used by us is entirely of the absorbable variety with the exception of the silkworm gut sutures in the vaginal wall. Formerly silk wire was used extensively for this purpose but we do not consider

that it has any advantage over the suture materials now available.

The description of the operation makes it seem so simple that one might expect uniformly satisfactory results, but such is far from the truth. Repair of the fistula is not effected at the first attempt as a rule as was seen in the review of cases encountered at the clinic in the past two years. Of 24 patients who presented themselves with vesicovaginal fistulas, the condition of 17 was considered to be suitable for operation. There had already been 48 attempts at closure on these 17 women. While they were under care at the clinic, it was necessary to do 23 operations. Four of them are not entirely cured as yet, and the end result of treatment of 1 other is questionable.

Usually, if the operation is carried out the first time as suggested, and if the fistula is 1 centimeter or less in diameter good results can be expected. However the prognosis of any one attempt is not good if the field in which one is working is mainly scar tissue resulting from previous operations. Sometimes it is impossible to secure sufficient tissue with adequate blood supply to allow closure of the defect, and transplantation of the ureters into the sigmoid becomes necessary. It is probably wise to transplant the ureters in two stages, although in selected cases Coffey's technique 2, in which both ureters are catheterized and transplanted at the same time, undoubtedly is highly satisfactory (Fig. 2). Transplantation has been done in several cases, one of which is reported in this paper. Lower and Phaneuf each have reported recently a similar case, in which pregnancy occurred later and successful delivery was accomplished by caesarean section.

The use of electrocoagulation has been suggested in recent years, mainly by European surgeons. Peterson reported 2 cases in this country in which union was secured by this means alone both of the fistulas were small. We have had no extensive experience with this method, but feel that best results are secured from this procedure when the fistula is not more than 1 or 2 millimeters in diameter, and then it should only be used in selected cases.

The 3 cases now to be reported illustrate different etiologic factors and methods of treatment.

CASE 1. An unmarried woman, 19 years of age, was delivered of a child at full term. Delivery was difficult and the use of forceps was necessary. Complete laceration of the perineal floor resulted, with laceration of the anterior vaginal wall, and separation of the symphysis pubis. The resultant rectovaginal fistula was repaired, union of skin and mucous membrane being secured, but not of the muscle layers, so that there was inadequate control of the



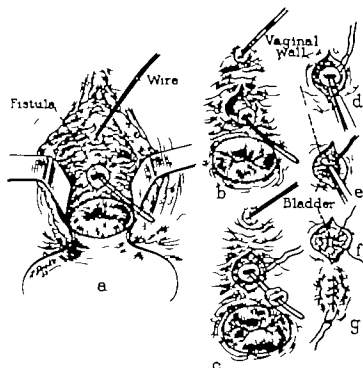


Fig. 1. Technique of closure of vesicovaginal fistula. *a*, The fistula is circumscribed, and a wire is run through the urethra into the bladder and out through the fistula. *b*, The fistulous tract is closed out. *c*, Any excess is excised. *d*, Tension is made on the wire with forceps. *e*, The pursestring suture in the bladder is pulled tight. *f*, The pursestring is tied and the bladder is closed in one direction. *g*, The vagina is closed separately.

bowel. The fistula into the bladder was later repaired four times, not in any instance with success for even a few days. When the woman presented herself at the clinic for the first time, there was a vesicovaginal fistula extending from the posterior surface of the symphysis pubis to the anterior lip of the uterine cervix. The fistula was large enough to admit two fingers, and most of the mass of the greatly contracted bladder was protruding through it (Fig. 3). There was no urethra. Although the two attempts to close the fistula that were made at the clinic resulted in some diminution in its size, it became apparent that the tissue available was insufficient to effect closure in the usual manner. It was evident, also, that to construct a urethra probably would be impossible, and that control of the flow of urine would not be had even if a urethra could be constructed. Accordingly the perineum was satisfactorily repaired, and then both ureters were transplanted into the sigmoid, according to the method of Coffey. The patient was allowed to return home 12 days after operation and she is now able to control her urine for as much as 4 hours during the day and all night.

**CASE.** A woman, 47 years of age, presented herself with a large vesicovaginal fistula. Three years before, following subtotal hysterectomy elsewhere for sarcoma which had developed in a fibroid tumor of the uterus, she had been treated with radium. A second application of radium to the uterine cervix was followed by the appear-

ance of a fistula so large that her referring physician felt that the ureters would have to be transplanted. No attempt at repair had been made. When the patient was examined, no recurrence of the malignant growth could be identified, and it was felt that she should not be denied the chance of repair. It was accordingly attempted in the conventional manner. Union was prompt and permanent, and recently she reported that there is no leakage of urine.

**CASE 2.** While a woman, 43 years of age, was still in the hospital following destruction of the endometrium by zinc chloride, a large vesicovaginal fistula developed. One month after her first operation an attempt was made to repair the fistula. This was not entirely successful, and diminishing amounts of urine continued to drain by vagina for the next 8 months. When the woman returned to the clinic, cystoscopic examination disclosed a small opening on the left side of the vagina. Repair of the fistula was accomplished, but some urine continued to drain into the vagina, and further examination revealed a second fistula, this one on the right side. Apparently the original repair had resulted in a bridge of tissue, leaving a fistula on each side, the left larger than the right. The opening on the right side was repaired, and then there was no leakage of urine. She now is troubled somewhat by frequency

In this case, and in one of ureterovaginal fistula, occurred the only urinary complication in series of 123 cases in which the endometrium was destroyed by using saturated solution of zinc chloride.

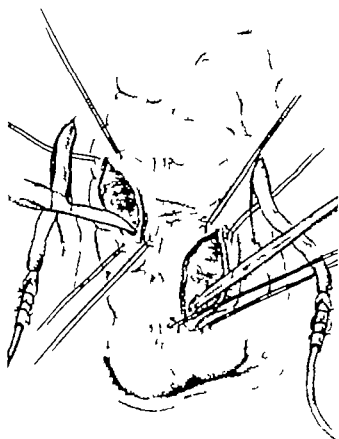


Fig. 2. Transplantation of ureters into the rectosigmoid (after Coffey)

of urination especially at night, undoubtedly because of the restricted capacity of the bladder

#### SUMMARY

It would seem that vesicovaginal fistulas following difficult labor might be allowed a chance to heal spontaneously, but the treatment of most of these fistulas and of all fistulas which follow operative procedures is primarily surgical. Dissection of the tract and inversion of the stump into the bladder, with free separation of the base of the bladder from the anterior vaginal wall and individual closure of these two structures give the best results. In certain cases in which there is extensive malignancy this procedure is not practicable, and either the fistula must remain, or both ureters must be transplanted into the sigmoid.

A review of 17 cases in which operation was performed during the last 2 years, revealed com-

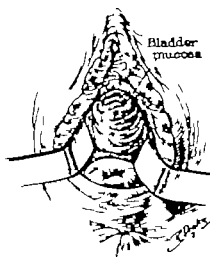


Fig. 3. Large vesicovaginal fistula. The mucosa of the anterior wall of the bladder is seen projecting through the fistula, which extends from the symphysis pubis to the uterine cervix. There is no urethra.

plete healing in 12 and diminished drainage in 4. In 1 case statements in the correspondence were not sufficiently clear to allow estimation of the degree of success.

#### BIBLIOGRAPHY

1. COFFEY R C Transplantation of the ureters into the large intestine. *Surg. Gynec. & Obst.* 1928 xlvii, 593-621.
2. DEUTSCHMAN D Obstetrical vesicovaginal fistulae, etiology and spontaneous closure with report of cases. *Med. J. & Rec.* 1932 cxxxv 486-489.
3. JUMP E S The operative treatment of vesicovaginal fistulae. *Surg. Gynec. & Obst.*, 1920 xxx, 447-453.
4. LOWER, W E. Vesicovaginal fistula. *Ann. Surg.* 1930 xci, 774-778.
5. MAYO C H. Repair of small vesicovaginal fistula. *Ann. Surg.* 1916 lxi, 106-107.
6. MAYO C H. and WALTERS WALTERMAN. The operative treatment of vesicovaginal fistulae. *Surg. Clin. N. America*, 1924, iv 399-406.
7. PETERSON ANDERS. Vesicovaginal fistulas treated by electrocoagulation. *Am. J. Surg.* 1932 xlv, 247-248.
8. PRANZUP, L. E. Vesico-vaginal fistula adherent to the right pubic ramus management of difficult case. *Am. J. Surg.* 1933 xli, 29-35.
9. SEARS, N P. Suprapubic transvaginal operation for vesicovaginal fistula. *Am. J. Obst. & Gynec.*, 1929 xviii, 267-273.
10. SIMS, J M. On the treatment of vesicovaginal fistula. *Am. J. Med. Sc.* 1852 xiv 59-62.

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN H. MARTIN, M.D.

ALLEN B. KARAVEL, M.D.

LOYAL DAVIS, M.D.

Managing Editor

Associate Editor

Associate Editor

DONALD C. BALFOUR, M.D.

Associate, Editorial Staff

JUNE, 1934

#### THE HESITATING SURGEON

ONE of the very last remarks of Sir James Paget to a young associate was

I have no use for the surgeon with a hesitating sphincter—of the brain. The implication seems to designate a surgeon who is afflicted with a mental tenesmus who is not quite sure of himself who is vacillating both in his opinions and in his actions. Such a temperament—for after all the manifestation must be temperamental—does not make for clear cut decision or execution nor does it allow for the wide advantages of knowledge and training. Actual vacillation is a handicap to a surgeon otherwise endowed with many other excellent qualifications. If however the hesitation is due to lack of knowing how all praise should be given to a conscience-stricken cerebral sphincter which may cause its possessor to realize that at times it takes more courage to back out than to go ahead.

No surgical procedure should be undertaken in the absence of a well planned and thought out course of action. Yet in many instances, the exact condition cannot be determined beforehand and even when a working diagnosis

is made surprises may be in store for those who enter. Here is no place for the hesitating surgeon but for the surgeon who is resourceful who can meet situations as they arise and whose decisions depend upon ripened experience. Once a line of action is chosen let it go on to completion this is a good resolution provided it is founded on recognized surgical principles and comports with the operator's trained judgment. In any event the operating surgeon is his own best adviser and the solely responsible factor in the scene. He is most likely to go wrong when he takes some by-stander's advice. If there is one particular thing to be avoided in the operating room it is a prolonged consultation at the table over the open wound. It is much more reprehensible than talking across the board in a card game.

To condemn hesitation is not to commend rashness. There are surgeons who have a hypertrophied audacity a boldness, which in itself is a useful talent but which carried too far leads them to rush in where angels fear to tread. The proper balance is happily held by Guy de Chauliac when he speaks of being 'bold in those things that are safe fearful in those things that are dangerous.

A crude example of the hesitating surgeon is the one who putters around before beginning an operation fusses along over the automatic details during an operation fondles the parts overmuch, as if to gain some unseen idea of the next step and finally finishes the operation with regret pining for the very joy of continuing. There is no more room left for the hazy surgeon than there is for the so called brilliant operator. Neither can one

justly decry deliberation, or taking time to consider. These are the mainstays of a gracefully performed operation. But, once having decided upon the procedure all else is to be subordinated to its conduct and its conclusion. Unnecessary manipulations are to be eschewed as leading to clumsy technique as well as being evidence of a hesitating mind. A comedy of errors may be worse than a tragedy of false motions, but in the end the results might be equal. Looking on at the work of a forthright surgeon—master of the job and of himself, one is tempted to use this paraphrase of an old proverb familiarly breeds repose.

To seek for a judicious balance of head and hand, to pray both for poise and purpose, to strive to be neither cocksure nor wavering, neither reckless nor timid—these are the ideal aims of the successful surgeon. If he who hesitates is lost, he who hurries may also fail.

HUBERT A. ROYSTER.

## SURGERY IN THE TREATMENT OF EPILEPSY

THERE are few widespread diseases into the management of which surgery has not penetrated at one time or another, sometimes brilliantly, sometimes blindly and followed by disaster, sometimes even inquisitively. For some time surgery made tentative inroads into the treatment of tuberculosis but at present, with the insight that has been gained into the principles of that disease it plays an important part in the attack on tuberculosis even of the lungs.

A less successful example is that of spastic paralysis which seemed for a time to come within the grasp of the surgeon. On the basis of a small amount of well conceived but, as it proved misleading experimental work, and after a few apparently successful sympathec-

tomies a new cure for this disability was proclaimed around the world and thousands of sympathetic ganglionated chains were sacrificed to easy credulity. Now that this wave of contagious enthusiasm has receded it becomes obvious that the procedure can never be more than an aid to physical therapy in the treatment of that condition although a restricted field has been found in the surgery of certain vasospastic conditions (Leriche Adson).

Epilepsy a curse which is as old as the race has been overtaken by waves of surgical attack. Simple decompressive operations, excisions of a normal motor gyrus, surgical alteration of venous drainage, cauterization of fluid lakes which passively overlay areas of cerebral atrophy, implantation of foreign bodies upon the surface of the brain, varying types of cervical sympathectomy, all of these and many more such as colectomy have been employed in the hope of bringing relief to the epileptics whose number on this continent has been estimated by Cobb at half a million.

After these tentative beginnings what is the status of surgery today in relation to epilepsy? Before an answer can be given to this question the "epilepsies" must be subdivided somewhat on an etiological basis for it is evident that an epileptic seizure is a common manifestation of many different abnormal conditions which affect the brain. 'Epilepsy' Hughlings Jackson said 'is the name for occasional sudden excessive rapid and local discharges of grey matter.' It is obvious that this discharge may begin in many different parts of the brain even in the cerebral autonomic centers just as in the motor cortex so that sweating or sudden rise of blood pressure may have a localizing significance on a par with twitching of the extremities.

But it is the cause back of that discharge of grey matter which is first to be considered

If this cause be tumor the remedial treatment is obviously surgery. Even in the absence of other signs of brain tumor epileptic seizures appearing for the first time in an adult who gives no history of trauma may well be attributed to this diagnosis until it can be disproved or until some other cause is found.

Trauma may produce in the brain a meningeal cicatrix which gives rise to epilepsy and which is susceptible to surgical attack. Such an injury to the brain received either at birth or later may often go unsuspected until the appearance of convulsive seizures. In many cases this traumatic lesion may prove to be so diffuse as to defy surgical intervention from the start. In other cases however the lesion is found to be so situated and so delimited as to render complete radical extirpation possible. With these cicatrices may be grouped also certain other non traumatic, focal lesions of the brain.

In the study of such lesions encephalography is an indispensable aid. Such a scar may exert a pull upon the whole brain through the vaso-astrial (vasoglial) framework. It becomes evident in the pneumogram that this cicatricial pull produces a migration of adjacent parts of the ventricle toward the lesion. Further at operation under local anesthesia faradic stimulation of a focal lesion often reproduces what is for the patient a typical seizure. If it be only an aura a sensory phenomenon the patient at once identifies it. If it be a convulsion the succession of movements follows his own peculiar pattern.

If finally the patient's history, the encephalogram, the pattern of the seizures and perhaps neurological examination all incriminate the same area of the brain then electrical exploration is justified. If this exploration is in accordance with the rest of the evidence complete radical excision of the focal lesion is the rational method of treatment, a treatment

which has been justified by its practical results.

But if post traumatic and neoplastic causes are excluded we are still faced by an army (the majority alas) of epileptics. What of them? Encephalography will show some to have an unequal atrophy of certain parts of the brain. Others present a diffuse advanced cerebral atrophy which may be related either to the cause or to the effect of the seizures while still other sufferers show no more than the slowly progressive cerebral atrophy which one must admit appears in all of us with advancing years.

For these cases of so called idiopathic epilepsy there is no approved or accepted surgical procedure. There may never be one although recent work on the innervation of the cerebral vessels has opened a new avenue for study. Contrary to earlier belief cerebral vessels are supplied with nerve fibers both within the pia and within the brain and furthermore sympathetic and parasympathetic nervous pathways have been traced to them capable of producing in the pial vessels at least visible constriction or dilatation.

These changes which may be produced in normal animals, though definite are slight in degree when compared with the vascular alterations which are seen in the epileptic brain upon the operating table for associated with, and subsequent to epileptic seizures in conscious patients, areas of anemia, complete arterial constriction, and obvious vascular dilatations occur in cases of habitual epilepsy. These changes have never been seen in normal patients and cannot be reproduced in the experimental laboratory.

Physiological instability of the cerebral blood vessels seems to be the abnormal condition which is common to all cases of epilepsy. The proof of this may be new but the supposition is old even antedating Hughlings Jackson who said in 1870 "It is, I speculate through

the arteries that sequence of movements is developed, whether these movements be spasms passing up the arm and down the leg or whether they be orderly sequences of movements in health."

But, unfortunately, clinical epilepsy is possible in the complete absence of all the sympathetic nerves which enter the cranial cavity in company with the carotid and vertebral arteries. Cervicothoracic sympathectomy is

therefore not the answer. Furthermore, experimental epilepsy is possible, according to unpublished work by Gage after section of the cerebral parasympathetic as well as the sympathetic nerves. Consequently before attempting to treat idiopathic epilepsy, the surgeon must await further elucidation of the mechanism involved in the discharge, as the physician still looks for further revelation of its ultimate causes.

WILDER PENFIELD

# EARLY AMERICAN MEDICAL SCHOOLS

## TRANSYLVANIA

DANIEL C. ELKIN M.D. F.A.C.S., ATLANTA, GEORGIA

THE struggle for education—a passion among Scotch-Irish settlers—went hand in hand with the struggle for the land in Kentucky and the new west. As early as 1779 we find Joseph Doniphan teaching at Boonesborough, and the year following John McKinney opened a school at Lexington.

In 1780 the State of Virginia placed eight thousand acres of escheated lands of "Kantuckee" county into the hands of thirteen trustees for the purpose of a public school or a seminary of learning. In 1783 Virginia re-endowed it with twelve thousand additional acres under the name of Transylvania Seminary. In 1785 a beginning of this seminary was made in a log cabin near Danville, and in 1789 it was located in Lexington, a town already showing promise of becoming the metropolis of the Bluegrass country. Transylvania Seminary by merging with the Kentucky Academy became Transylvania University by act of the General Assembly of Kentucky in 1798 and the year following its trustees

instituted the medical department and appointed Dr. Samuel Brown as professor of chemistry, anatomy and surgery and Dr. Frederick Ridgely as professor of materia medica, midwifery and practice of physic. Thus was founded the first medical school west of the Alleghanies, destined because of its faculty, its library and the number and influence of its students to play an important rôle in the *History of the West*.

The teaching of students was at first by occasional lectures and by apprenticeship to the professors, and not until 1817 was the first student graduated with the doctor of medicine degree. By that time Benjamin Dudley, professor of anatomy and surgery, James Overton, professor of theory and practice, Daniel Drake, professor of materia medica, William Richardson, professor of obstetrics, and James Blythe, professor of chemistry had been added to the staff. Charles Caldwell became professor of physiology and the Institutes of Medicine in 1819.

This was a faculty second to none, the country was rapidly growing in population and by state and private donations an excellent library was added to the school. So it is small wonder that its growth was so rapid that by 1823 there

Harrodsburg, the first settlement in Kentucky, was established in June, 1774. Boone cut the Wilderness Road and built Harrodsburg the following year. George Rogers Clark's expedition against Kentucky and its environs took place in 1778-79. Indian fighting continued in Kentucky as late as 1811 (Boyer's Station and Blue Lick).



Dr. Samuel Brown (From portrait at Frankfort, by Jouett.)



Dr. Benjamin W. Dudley (From portrait by Jouett owned by Mrs. Robert Peter.)

were 200 students and 46 graduates. In its 40 years of existence Transylvania enrolled 6,456 medical students and granted its medical degree to 1,881, a record unsurpassed by any school. The academic department kept pace with the medical school, and in 1823 when Jefferson Davis was a student, it had the largest student body in America, and its courses were as advanced as those of Yale or Harvard.

The faculty was widely known because of the numerous publications of its members in medical and scientific journals. Samuel Brown was among the first to accept Jenner's ideas for as early as 1802 he had vaccinated over five hundred people with cowpox. Aside from his work in medicine, he was a leading geologist and published numerous articles in Silliman's *Journal* and the *American Philosophical Transactions*.

Perhaps more widely known was Brown's successor, Benjamin W. Dudley. He obtained his medical degree at the University of Pennsylvania in 1806 and studied in Europe until 1814 when he settled in Lexington. While abroad he became a member of the Royal College of Surgeons. He was professor of anatomy and surgery at Transylvania until 1850. He excelled as a lithotomist, having performed the operation two hundred and twenty five times with a mortality of less than 2 per cent. He insisted on the use of boiled water in his operations. He wrote voluminously for the *Transylvania Journal of Medicine* publishing a paper on skull fractures as a cause of epilepsy with five successful trephines for the condition. He was probably the first surgeon in the United States to perform this operation.

A picturesque character and a vital part of the school was Charles Caldwell. Brilliant, polished eloquent, but vain and egotistical, he had won a place on the faculty of his Alma Mater the University of Pennsylvania. But his stay there was short lived, for he fell into disrepute with his friend and teacher, Benjamin Rush. Finding the doors of the University of Pennsylvania closed to him he turned to Transylvania, where he taught the Institutes of Medicine from 1814 to 1837. To Caldwell, more than anyone else, must go the credit for the medical library, the school's most valuable adjunct, and now a notable collection of incunabula and classic first editions. With \$13,000 secured from the Kentucky legislature Caldwell visited Paris in 1820 for the purpose of purchasing books. He writes in his biography "I found and purchased at reduced prices no inconsiderable number of the choicest works of the fathers of medicine from Hippocrates to the

THE  
TRANSYLVANIA JOURNAL  
—  
OF  
MEDICINE  
AND THE ASSOCIATE SCIENCES



VOL. • NO 3.—AUGUST 1820.—

LEXINGTON, KENTUCKY  
PUBLISHED BY J. M. W. PALME, JR. & COMPANY  
Printed at the Transylvania Press,  
LEX. 20 1820.

Title page from the *Transylvania Journal of Medicine* showing first medical building erected 1827

revival of letters. Works which in no other way and perhaps at no other time could have been collected so readily and certainly on terms so favorable. Again in 1839 Dr. Robert Peter the professor of chemistry spent in London and Paris \$11,000 for books and apparatus.

Of equal influence among the early teachers was Daniel Drake, who became professor of materia medica in 1817, but left Lexington the following year to found the Medical College of Ohio at Cincinnati. Due to dissensions in the faculty there he resumed his chair at Transylvania and became Dean of the Faculty until 1827 when he left again to occupy a similar chair at Jefferson. He was a prolific writer being editor of the *Western Journal of the Medical and Physical Sciences* and the author of a two volume medical treatise. He had a great influence on medical education always insisting upon raising the standards for graduation.

Charles Willins Short, because of excellence and originality of his botanical collections (*Shortia*



*Galacifolia Vesicaria Skottus Aster Skottii*) brought fame and influence to the school, as did Eliha Bartlett that peripatetic physician who held professional chairs at one time or another in the Berkshire Medical Institute Dartmouth Transylvania Maryland Vermont and the College of Physicians and Surgeons in New York.

The decline of Transylvania and its final dissolution was due largely to a shifting population for Lexington without railroad or water transportation was rapidly giving way to Louisville, on the Ohio, as a metropolis. Nor could Transylvania compete with the rival schools at Louisville and Cincinnati with their greater clinical facilities.

By the year 1850 the number of students had decreased to fifty and in that year Benjamin Dudley its most famous teacher retired. Dissensions in the faculty took some of its best members to the Louisville Medical Institute. Notwithstanding the efforts of zealous Trustees, not withstanding the diligence of an able Faculty the classes steadily decreased from year to year until, in 1857 with only nine graduates, the Faculty in despair disbanded, and the time honored Medical Department of Transylvania University was no more."

The author acknowledges his indebtedness to "The History of the Medical Department of Transylvania, by D. Robert Peter Filson Club Publication, 1905.

# THE SURGEON'S LIBRARY

## REVIEWS OF NEW BOOKS

THE book<sup>1</sup> by Kenneth M. Walker entitled *The Enlarged Prostate and Prostatic Obstruction* is a concise, modern conception of prostatism. The book has been revised because of the recent advances in the treatment of prostatism by transurethral methods. Changes in the prostate and the prostatic age are likened to the climacteric of females.

Although cystoscopy is the best method of exact diagnosis of bladder neck obstruction it should not always be done because of old age, large residual urines, and general poor risk. The chapter on general treatment of the prostate is to be highly commended.

The author prefers suprapubic prostatectomy because perineal dissection endangers the rectum and offers poor exposure of the vesical neck. Freyer's technique of a suprapubic prostatectomy is described. Gas and oxygen or sacral anesthesia should be used. Spinal anesthesia is particularly liable to invite thrombosis.

True contracture of the vesical neck or prostatic bar are termed dysectasia of the bladder neck.

Transurethral resection is reserved for cases in which the amount of prostatic enlargement is small or the removal of the prostate gland is contra-indicated or there is carcinomatous obstruction of the vesical neck.

It is emphasized that carcinoma of the prostate gland is not uncommon this entity should be excluded in all men over 50 years of age, who have difficulty in urination. The value of radium in the treatment of prostatic cancer cannot be exactly evaluated. It is known that the X ray will alleviate pain in some cases. Cystotomy gives the best relief from obstruction and its concomitant painful cystitis, transurethral resection is used by most workers.

The chances of the prostatic patient in recovering from the operation is something more than 90 per cent and the probability of continued life in entire comfort is over 70 per cent.

Walker's work is considered an excellent treatise on prostatism.

HARRY CULVER.

THREE lectures given by Dr. Cannon under the auspices of the Beaumont Foundation of the Wayne County Medical Society, Detroit, Michigan have been gathered together in a single volume.<sup>2</sup>

THE ENLARGED PROSTATE AND PROSTATIC OBSTRUCTION. By Kenneth M. Walker, F.R.C.S. M.B. B.C. 2d ed. London: Oxford University Press, 1933.

THE MODERN EXTENSIONS OF BEAUMONT'S STUDIES ON ALKALIS. By MARTIN BEAUMONT FOUNDATION LECTURES. By W. B. Cannon, M.D., D.Sc., LL.D. Detroit: The Journal of the Michigan State Medical Society 1932.

One of the lectures is on Thirst and Hunger,<sup>3</sup> another on The Important Relations of Digestion and Health and another on Digestive Disturbances Produced by Pain and Emotional Excitement. The lectures consist of a delightful and authoritative presentation of pertinent subject matter of use in the every day practice of medicine and surgery.

THE subject of emboli has been reviewed by Frey in a very thorough manner. In this monograph<sup>4</sup> of nearly 300 pages, he has presented a graphic and exhaustive description of the pathogenesis of thrombosis and embolism. The German literature has been thoroughly reviewed and there is a well classified bibliography appended to the work.

Blood fat air and foreign body emboli are discussed in considerable detail. The clinical side of the subject has been covered fully but succinctly. About 30 pages are given over to the subject of pulmonary embolism. This part of the work is well illustrated and well organized.

The monograph is written in a style which will interest the student and clinician rather than the research worker in this field. Very little space is given to the question of physical chemistry with which this subject is now suffused.

The diction and sentence structure is sufficiently simple and lucid to enable those not expert in German translation to follow the text with ease and profit.

The monograph is well illustrated and there are a number of very interesting and instructive tables contained in the work.

RAYMOND W. MCNEALY

THE section on tuberculosis of the female genitalia in Veit's *Handbuch der Gynäkologie*<sup>5</sup> is written by Heynemann who discusses at length all phases of this disease. The author is definitely against active surgical therapy is convinced that surgery is passé and discusses in detail all forms of light and roentgen therapy. Yet the reader looks in vain for any mention of oxygen pneumoperitoneum either for diagnosis or therapy. The discussion of climate and altitude is of interest, even though the American reader must disagree with the author's conclusions.

The section on diseases of the pelvic connective tissue by Freund is outstanding. It is simply and

<sup>1</sup>THE ENDOCRINE. By Dr. Alfred Frey. Leipzig: Georg Thieme, 1931.

<sup>2</sup>VEIT'S HANDBUCH DER GYNAKOLOGIE. Edited by W. Staeckel. Vol. VIII, part 1.—Beachtliche Entwicklung Gestalt: berrühendes Krankheitsbild der Beckenbodenorgane. Edited by R. Freund, Th. Heynemann. G. Fischer Verlag, J. F. Bergmann, 1931.

clearly written beautifully illustrated, and is a complete monograph on the subject. **RALPH A. REIS.**

**ACUTE** and chronic infections of the female genitalia are discussed in part 2 of volume VIII of Veit's system on gynecology. The author is Bucura of Vienna who is well known for his earlier writings on this subject. With the exception of gonorrhea and tuberculosis, all infections are considered, including the uncommon types of infections such as typhoid, diphtheria, influenza, tetanus, actinomycosis, ecchymococcus, etc.

It is desirable of course, to include all types of infections in a complete monograph such as this, but a great deal of time, effort, and expense could have been saved by the omission of the long and detailed accounts of the various bacteria and parasites which produce these diseases. After all this is a study primarily of gynecology and not of bacteriology or parasitology.

The discussion of the reticulo-endothelial system is especially praiseworthy as is the section on hematology. The bibliography is as usual, most complete. This volume is excellently illustrated and stands out in this respect with other volumes of this series which have been previously reviewed. It will prove to be an excellent reference work.

**RALPH A. REIS.**

**IT** is surely a valuable contribution to the literature of radiation therapy to have in this single volume<sup>1</sup> by Holthusen a presentation of the historical, physical and biological foundations for accurate dosage

<sup>1</sup> *NEU' HANDBUCH DER GYNEKOLOGIE*. Edited by W. Stoeckel. Vol. VIII, part 2.—Die akuten und chronischen Infektionen der Genitalorgane mit Ausnahme der Tuberkulose und Gonorrhoe. By C. Bucura. Munich: J. F. Bergmann, 1933.

<sup>2</sup> *GYNECOLOGY AND PRACTICE WITH ROENTGENRADIATION AND RADIATION DOSEMEASUREMENTS AND DOSEMEASUREMENTS*. By Prof. Dr. med. H. Holthusen, in collaboration with Dr. med. R. Ertel. Leipzig: Georg Thieme, 1933.

measurement in radiation therapy with chapters on the practical applications and determinations of radiation dosage. It would be a revelation to the average physician to have the opportunity of turning through the pages of this work to gain some slight appreciation of the fact that roentgen and radium dosage measurements are very complicated, requiring much time devoted to study and practice in the various methods available, and proficiency in at least one of the methods. To the physician dealing with practical radiation therapy this work affords a mine of information of a very precise character dealing with the various problems of dosage determination.

**JAMES T. CASE.**

**THE** book by Hewer and Sanders<sup>1</sup> is primarily an outline of information concerning the nervous system of man. It is neither a textbook of neuro-anatomy nor one of neurophysiology. Although the histological structure of nervous tissues does receive some attention, the book takes as its scope primarily the fiber tracts and functional neurological concepts. It contains a great many facts not found in any other single book; these are presented in abridged form. Since most of the subject matter is presented in tables, outlines, and notes which do not make economical use of page space, the size of the volume belies the amount of material it contains. The authors have indulged in extravagant use of simplified colored diagrams of conduction pathways; these occupy unnumbered inserted pages. An appendix of technical methods and an index are to be found at the end of the volume. A few references to the literature appear at the ends of chapters.

**WILLIAM F. WINDLE.**

<sup>1</sup> *AN INTRODUCTION TO THE STUDY OF THE NERVOUS SYSTEM*. By E. F. Hewer, D.Sc. (Lond.), and G. M. Sanders, F.R.C.S. (Eng.), M.B., B.S. (Lond.), ed. ed. London: William Heinemann (Medical Books) Ltd., 1933.

## CORRESPONDENCE

### A PLEA FOR PROPHYLACTIC INTERVENTION IN THE SECOND STAGE OF LABOR—A Correction

In the May 1934, issue of **SURGERY GYNECOLOGY AND OBSTETRICS**, in the article entitled "A Plea for

Prophylactic Intervention in the Second Stage of Labor" by Dr. James Robert Goodall, a typographical error was made in stating the dosage of infundin. In line 13, right column, page 883, the dosage should be 0.5 cubic centimeter.

# CLINICAL CONGRESS OF AMERICAN COLLEGE OF SURGEONS

WILLIAM D HAGGARD *Nashville President*

ROBERT B GREENOUGH *Boston President Elect*

FRANKLIN H. MARTIN, *Chicago Director-General*

ARTHUR W ALLEN *Chairman* ERNEST M DALAND *Secretary Committee on Arrangements*

## PRELIMINARY PROGRAM FOR THE CLINICAL CONGRESS IN BOSTON

THE twenty fourth annual Clinical Congress of the American College of Surgeons will be held in Boston October 15-19 1934. The surgeons of that great medical center have organized under the leadership of a strong and representative committee planning to provide for the Fellows of the College and their guests a program of surgical clinics and demonstrations that will present a most complete showing of their clinical activities in all departments of surgery. The Committee on Arrangements has been assured of the hearty co-operation of the clinicians at the medical schools and more than thirty hospitals that will participate in the clinical program.

In the following pages there is published a preliminary program of clinics and demonstrations as prepared by the Committee on Arrangements. It should be noted that operative clinics and demonstrations in the hospitals are scheduled for the afternoon of Monday, October 15 beginning at 2 o'clock, and for the mornings and afternoons of each of the four following days. The schedules appearing herewith are to be revised and amplified as the work of the program committee progresses during the intervening months. All departments of surgery will be represented in the program—general surgery, gynecology and obstetrics, urology, orthopedics, neurosurgery and surgery of the eye, ear, nose and throat.

Special features of the clinical program include (1) Demonstrations of modern methods in the treatment of fractures (2) cancer clinics demonstrating the treatment of cancer by surgery, radium and X ray, (3) clinics in traumatic surgery demonstrating methods of rehabilitation of injured patients by surgery and physiotherapy.

The following hospitals and schools will participate in the clinical program.

Beth Israel Evangeline Booth Maternity, Boston City Boston Dispensary Boston Lying In

Peter Bent Brigham Robert B Brigham Cambridge Cambridge City Carney Chelsea Children's, Faulkner, Free Hospital for Women Huntington Memorial Lakeville Sanatorium Long Island Malden Massachusetts Eye and Ear Infirmary Massachusetts General Massachusetts Memorial Massachusetts Women's New England Baptist, New England Deaconess, New England Hospital for Women and Children Newton Palmer Memorial Peabody Home Pondville St. Elizabeth's State Prison Colony Symmes Arlington and Waltham hospitals Boston University Harvard University and Tufts College medical schools.

A tentative outline of the programs for a series of five evening sessions as prepared by the Central Executive Committee will be found in the following pages. The first formal session of the Congress the presidential meeting on Monday evening will be held in Symphony Hall at which the president-elect, Dr Robert B Greenough, of Boston will deliver his inaugural address. On that occasion a number of distinguished surgeons from abroad who will be in attendance at the Clinical Congress will be introduced. A feature of the evening will be the John B. Murphy oration in surgery by Dr Donald C Balfour. Sessions on Tuesday Wednesday and Thursday evenings will be held in the ballroom of the Copley Plaza at which a number of eminent surgeons of the United States and Canada together with visiting surgeons from foreign countries will present papers dealing with surgical subjects of timely importance. The annual Convocation of the College will be held on Friday evening in Symphony Hall at which the 1933 class of candidates will be received into Fellowship in the College.

Special features of this year's Clinical Congress will include (1) A symposium on cancer under the auspices of the College Committee on the

Treatment of Malignant Diseases on Wednesday afternoon at which further reports by clinicians from various parts of the country will present additional statistics on the cure of cancer. The program will include a series of papers on the treatment of cancer descriptive of modern methods of treatment and the organization and administration of cancer clinics. (2) A conference on fractures arranged by the College Committee on the Treatment of Fractures on Tuesday afternoon. (3) A conference under the auspices of the Board of Industrial and Traumatic Surgery on Friday afternoon.

On Thursday at 3.30 p.m. following the annual meeting in the ballroom of the Copley Plaza Hotel a symposium on "Diseases of the Esophagus" will be presented, as follows.

An X ray Study on Lesions of the Esophagus (statistical study with lantern slide demonstration) A. S. MACMILLAN

Infection of the Esophagus in Acute and Chronic Disease: Fibrosis of the Terminal Portion of the Esophagus (Cardiophagum) Etiology and Treatment. HARRIS P. MOORE

The Surgical Approach to the Esophagus. EDWARD D. CROCHILL

A program of ophthalmological and otolaryngological clinics and demonstrations at the hospitals and medical schools as prepared by the committee in charge of the section on surgery of the eye, ear, nose and throat appears in the preliminary clinical program. In addition, the committee has prepared programs for a series of four sessions on Tuesday Wednesday Thursday and Friday afternoons in John Hancock Hall, located on St. James Avenue midway between the Statler and Copley Plaza Hotels. Distinguished specialists in these branches of surgery will present and discuss papers on subjects of timely interest.

Either Day will be celebrated at the Massachusetts General Hospital on Tuesday with special exercises at 4 p.m. in the dome room of the old building of the hospital where ether was first administered for the production of surgical anesthesia on October 16 1846.

During the Congress surgical motion picture films, both sound and silent, will be exhibited daily in the Georgian Room at the Statler Hotel. The showing of films demonstrating clinical features of interest has met with popular acceptance in recent years. Many new films will be shown at this Congress.

The annual hospital conference will open the Congress with a session in the ballroom of the Copley Plaza Hotel at 10 o'clock on Monday morning. An interesting program of papers, round table conferences and practical demon-

strations dealing with problems related to hospital efficiency is being prepared for sessions to be held on Monday Tuesday, Wednesday and Thursday mornings in the ballroom of the Copley Plaza Hotel, with afternoon sessions at several of the hospitals. A greatly increased interest on the part of surgeons in both the administrative and scientific phases of hospital work has been evidenced in recent years and the program for this year's conference will be unique in providing for discussions of subjects of interest to the three major hospital groups—medical, surgical and administrative. The College aims to make this year's program of wide interest and practical character through a careful selection of subjects to be presented and discussed by surgeons and hospital executives, particular emphasis being directed toward professional standards and the vital problems related to medical economics.

Headquarters for the Congress will be established at the Statler and Copley Plaza Hotels. At the former the grand ballroom and adjacent assembly room, together with other large rooms on the mezzanine floor have been reserved for registration and clinic ticket bureaus, bulletin boards, exhibits, executive offices, etc. while the ballroom at the Copley-Plaza will be utilized for the evening scientific meetings, hospital conferences and other large gatherings.

The Technical Exhibition will be located in the ballroom and adjoining assembly room at the Statler Hotel. The registration and clinic ticket desk, together with the information bureau will be located in these rooms in which will also be found the bulletin boards on which the daily clinical programs will be posted each afternoon. The leading manufacturers of surgical instruments, X ray apparatus, operating room lights, hospital apparatus and supplies of all kinds, ligatures, dressings, pharmaceuticals and publishers of medical books will be represented in this exhibition.

In addition to the two headquarters hotels, the Statler and Copley Plaza, there are a number of first-class hotels within walking distance of headquarters. Among the hotels recommended by the Committee on Arrangements are the following: Bellevue Bradford, Brunswick, Buckminster Graylyn, Kenmore, Lenox Manger Parker House Puritan, Ritz Carlton, Sheraton, Touraine, Victoria and Westminster. While there are ample hotel facilities and there should be no difficulty in securing first-class accommodations, it is advisable for those who expect to attend the Clinical Congress to reserve their accommodations as far in advance as possible.

We are assured that the railways of the United States and Canada will grant low rates for the Clinical Congress in Boston. Applications for reduced fares for this meeting are now pending before the various railway traffic associations.

#### ADVANCE REGISTRATION

The hospitals and medical schools of Boston afford accommodations for a large number of visiting surgeons, but to insure against overcrowding, attendance at the Congress will be limited to a number that can be comfortably accommodated at the clinics—the limit of attendance being based upon the result of a survey of the amphitheaters, operating rooms, and laboratories of the hospitals and medical schools to determine their capacity for visitors. It is expected, therefore, that those surgeons who wish to attend the Clinical Congress in Boston will register in advance.

Admittance to all clinics and demonstrations will be controlled by means of special clinic tickets, which plan provides an efficient means for the distribution of the visiting surgeons among the several clinics and insures against overcrowding as the number of tickets issued for any clinic will be limited to the capacity of the room in which that clinic will be given.

A registration fee of \$5.00 is required of each surgeon attending the annual Clinical Congress, such fees providing the funds with which to meet the expenses of the meeting. To each surgeon registering in advance a formal receipt for the registration fee is issued, which receipt is to be exchanged for a general admission card upon his registration at headquarters. This card which is non transferable, must be presented in order to secure clinic tickets and admission to the evening meetings.

### COMMITTEE ON ARRANGEMENTS

#### EXECUTIVE COMMITTEE

ARTHUR W. ALLEN, Chairman	ROBERT B. GREENOUGH
ERNEST M. DALAND, Secretary	FREDERICK C. IRVING
ALEXANDER S. BEGG	FRED B. LUND
HORACE BINNEY	RICHARD H. MILLER
DAVID CHURCHER	FRANK OBER
FREDERIC J. COTTON	GEORGE L. TOBEY

#### HOSPITAL AND SCHOOL REPRESENTATIVES

BLANCHER L. ATWOOD	OTTO J. HERMANN
HAROLD L. BARCOCK	GEORGE W. HOLMES
GEORGE H. BIGELOW	GILBERT HORRAX
WALTER BOWERS	HENRY T. HUTCHINS
WILLIAM E. BROWN	CHARLES I. JOHNSON
RICHARD CATTILL	STEPHEN JONES
HENRY D. CHADWICK	GEORGE F. KEENAN
EDWARD D. CHURCHILL	WILLIAM E. LADD
HOWARD CLUTE	FRANK H. LAKEY
ROBERT C. COCHRANE	WALTER B. LANCASTER
E. GRANVILLE CRAWFORD	HARRY J. LEE
ELLIOTT C. CUTLER	EDWARD D. LEONARD
LORENZO DAVIS	HALEY B. LOVER
HILBERT F. DAY	MOSES H. LURIE
AUGUSTUS W. DUDLEY	FRANCIS X. MAHONEY
JOHN C. ECKELS	PATRICK J. MAHONEY
DAVID EDMALL	HENRY C. MARBLE
JACOB FIRE	LELAND S. MCKINTUCK
SEYMOUR FITCH	JOE V. MEIGS
NICHOLAS GALLAGHER	CHARLES G. MIXTER
H. QUINCY GALLUPE	WILLIAM J. MIXTER
HARRY H. GERMANN	GORDON MORRISON
MAGNUS L. GREGGERSON	HARRIS P. MOSHER

DWIGHT O'HARA	JOSEPH STANTON
ROBERT B. OSGOOD	A. WARREN STEARNS
ALONZO K. PAINE	HORACE P. STEVENS
FRANK A. PEMBERTON	LORING T. SWAIN
LOUIS E. PHANKUP	CHANNING SWAN
WILLIAM C. QUINBY	THEODORE L. TERRY
LYMAN RICHARDS	J. HERBERT WAITE
GRACE E. ROCHEFORD	IRVING J. WALKER
HORATIO ROGERS	SHIELDS WARREN
CHARLES L. SCUDDER	RALPH WIGGIN
WILLIAM M. SHEDDEN	CHARLES F. WILLIMSKY
CHANNING C. SIMMONS	PHILIP D. WILSON
M. N. SMITH PETERSEN	EDWARD L. YOUNG, JR.

#### SUB-COMMITTEES

Clinical Program—RICHARD H. MILLER, Chairman
HORATIO ROGERS, Secretary
Scientific Exhibits—ROBERT B. GREENOUGH, Chairman
CHANNING C. SIMMONS, Secretary
Harvard Medical School Program—DAVID CHURCHER, Chairman
MAGNUS I. GREGGERSON, Secretary
Publicity—FREDERICK J. COTTON, Chairman
GORDON MORRISON, Secretary
Entertainment of Foreign Guests—HORACE BINNEY, Chairman
WILLIAM M. SHEDDEN, Secretary
Public Meeting—ALEXANDER BEGG, Chairman
DWIGHT O'HARA, Secretary
Clinical Bulletin—FRANK OBER, Chairman
Ophthalmology and Otolaryngology—GEORGE TOBEY, Chairman
LYMAN RICHARDS, Secretary, Otolaryngology; THEODORE L. TERRY, Secretary, Ophthalmology

## OPHTHALMOLOGY AND OTOLARYNGOLOGY—SCIENTIFIC SESSIONS

*Tuesday—John Hancock Hall 2—Ophthalmology*

- JOHN M. WHEELER**, New York. Plastic ophthalmic surgery.
- JONAS S. FRIEDENWALD**, Baltimore. Slit lamp ophthalmoscopy.
- CLARENCE KING**, Cincinnati. Tuberculin in the treatment of ocular tuberculosis.

*Wednesday—John Hancock Hall 2—Otolaryngology*

- THOMAS E. CAMBORY**, Denver. Congenital deformities of the face and neck. Discussion opened by V. H. KAWAMURA.
- LOUIS H. CLARY**, Philadelphia. Personal endoscopy in otolaryngological practice.
- SAMUEL J. KOWTCH**, Baltimore. Meniere's symptom complex. Discussion opened by PHILIP M. KETTER.
- JOHN R. P. OF NEW YORK**. Acute infections of the middle ear and mastoid.
- O. JASON DYSON**, Kansas City. A departure in the management of acute mastoid disease or the advantages of conservative treatment in acute mastoid disease. Discussion opened by LAMAR RICHMOND.
- GEORGE H. COVET**, Philadelphia. Diagnosis of chronic infection of the tonsils in relation to indications for operation in cases of chronic focal infection.
- WILLIAM V. MULLIN**, Cleveland. Present status of infection of the upper respiratory tract in its relation to focal infection. Discussion opened by H. VINCIGUADAL NINNES.
- EDWARD ZEIGLMEYER**, San Francisco. The clinical and surgical significance of the component cellular characteristics of the temporal bone based upon series of 100 cases and autopsy observations, lantern slide demonstration.

*Thursday—John Hancock Hall 2—Ophthalmology*

- LUTHER C. PETER**, Philadelphia. How to treat disturbances of binocular vision by exercises, the use of the stereoscope in the treatment of heterophoria and heterotropia.
- CLIFFORD B. WALKER**, Los Angeles. The surgical treatment of separated retina.
- C. N. SMITH**, Minneapolis. The cataract operation.

*Ballroom Copley-Plaza Hall—3:30*

- An X-ray Study on Lesions of the Esophagus (statistical study with lantern slides). A. S. MACMILLAN.
- Infection of the Esophagus in Acute and Chronic Disease. Fibrosis of the Terminal Portion of the Esophagus (Cardiospasm). Etiology and Treatment. HARRY P. MORTON.
- The Surgical Approach to the Esophagus. EDWARD D. CHURCHILL.

*Friday—John Hancock Hall 2—Otolaryngology*

- SAMUEL J. KOWTCH**, New York. Recent developments in the diagnosis of meningitis.
- WELLS P. ENGLISH**, Newark, N. J. Meningitis—result of disease of the petrous apex and sphenoidal bone.
- MARTIN F. JONES**, New York. Pathways of approach to the petrous pyramid. Discussion by HARRY P. CANNIL.
- WILLIAM MITCHELL**, Cincinnati. When and how shall nasal sinus inflammation be treated nonsurgically?
- EDWARD C. SWEET**, San Francisco. Operative treatment of sinusitis, external approach. Discussion opened by CHARLES T. PORTER.
- GABRIEL TUCKER**, Philadelphia. Cancer of the larynx.
- HENRY B. ORTON**, Newark, N. J. Cancer of the laryngopharynx. Discussion opened by LEROY A. SCHALL.

## SCIENTIFIC EXHIBITS

**AT HEADQUARTERS, STATLER HOTEL**

- FRACTURES**. Demonstrating methods of treating fractures, under the auspices of the New England Fracture Committee of the American College of Surgeons.
- PLASTIC SURGERY**. An exhibit of models, photographs and diagrams, illustrating the different methods employed in plastic surgery and the results.
- TRAUMATIC SURGERY**. Diagrams, photographs and charts.
- ORTHOPEDIC SURGERY**. An exhibit of splints and other forms of orthopedic apparatus, together with charts and photographs.
- MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH**. An exhibit illustrating the activities of this department.
- CANCER**. An exhibit from the Palmer Memorial Hospital, Collis P. Huntington Memorial Hospital and the Pondville State Cancer Hospital. Lantern slides, charts and photographs illustrating cancer of the various organs of the body; the diagnosis and the results obtained by different forms of treatment. Also, an exhibit of specimens of cancer from many parts of the body.
- OPHTHALMOLOGY**. Charts and photographs illustrating melanotic sarcoma and other conditions of the eye.
- PATHOLOGY**. The specimens removed at operations from the various hospitals in the morning will be collected and placed on exhibition in artificially cooled showcases in the afternoon, in a room adjoining the Georgian Room.

At 5 p.m. these specimens will be demonstrated in the Georgian Room by a projectoscope, the microscopic sections shown and the cases discussed.

**AT HOSPITALS AND MEDICAL INSTITUTIONS**

- HARVARD DENTAL SCHOOL**. An exhibit of models, photographs and diagrams showing the restoration of extensive defects and deformities of the face and jaws by plastic surgery and dental prosthesis, including cases of soldiers wounded in the world war.
- BOSTON MEDICAL LIBRARY**. Exhibit of historical books on surgery and anatomy and surgical medals. Historical program illustrating the development of surgery. Wednesday, October 17, John Ware Hall, 2 p.m. presented by the students of Tufts College Medical School under the direction of Professor B. Spector. Exhibition of works of art by Massachusetts physicians under auspices of the Physicians Art Society.
- MASSACHUSETTS GENERAL HOSPITAL**. An exhibit in the Ether Dome relative to the first public demonstration of ether anesthesia. Showing of moving picture "The First Public Demonstration of Ether Anesthesia."
- MASSACHUSETTS CHARITABLE EYE AND EAR INFIRMARY**. Anatomical specimens and ophthalmological instruments.
- HARVARD MEDICAL SCHOOL, WARREN MUSEUM**. Anatomy anatomical specimens pathology pathological specimens.

## PRELIMINARY PROGRAM FOR EVENING MEETINGS

*Presidential Meeting—Monday—October 15 8 15 p m.*

Address of Welcome ARTHUR W ALLEN M D Boston Chairman Committee on Arrangements  
Introduction of Foreign Guests FRANKLIN H MARTIN M D Chicago Director General  
Address of Retiring President WILLIAM D HAGGARD M D Nashville, Tenn  
Inauguration of Officers  
Inaugural Address ROBERT B GREENOUGH M D Boston  
John B Murphy Oration in Surgery DONALD C BALFOUR, M D Rochester Minn.

*Tuesday—October 16 8 15 p m*

Living Grafts of Thyroid and Parathyroid Glands. HARVEY B STONE M D., Baltimore with the collaboration of JAMES C OWINGS M.D and GEORGE O GUY M D Baltimore  
Endocrinology EMIL NOVAK, M D Baltimore

*Wednesday—October 17 8 15 p m*

Symposium on Congenital Deformities  
Hydrocephalus and Spina Bifida. WILDER PENFIELD M D Montreal  
Congenital Deformities of the Genito-Urinary Tract HERMAN C BUMPUS M D Rochester Minn  
Sterility with Special Reference to Surgical Possibilities. BETHEL SOLOMONS M D, F.R.C.P.I Dublin Ireland  
Diverticulosis and Diverticulitis. IRVIN ABELL, M D Louisville

*Thursday—October 18 8.15 p m*

Symposium on Treatment of Infections  
Infections of Clean Operative Wounds. FRANK L. MELENEY M D New York  
Infections of the Lip and Face. FREDERICK A. COLLIER, M D Ann Arbor Mich  
Phagedenic Ulcer EMILE HOLMAN M.D San Francisco  
The Repair of Defects Resulting from Full Thickness Loss of Skin from Burns. JAMES B BROWN M D St. Louis

*Convocation—Friday—October 19 8 15 p m*

Invocation  
Presentation of Candidates for Fellowship FRANKLIN H. MARTIN M D Chicago Director-General  
Conferring of Fellowships. The President  
Conferring of Honorary Fellowships. The President  
Presidential Address. ROBERT B GREENOUGH M.D, Boston  
Fellowship Address



## PRELIMINARY CLINICAL PROGRAM

GENERAL SURGERY GYNECOLOGY OBSTETRICS, ORTHOPEDICS, UROLOGY  
PROCTOLOGY SURGICAL PATHOLOGY ETC.

## MASSACHUSETTS GENERAL HOSPITAL

## Monday

- Staff—2. Dry clinic. A. W. ALLEN. Bleeding peptic ulcer. JOHN STEWART. Water balance in the surgical patient. C. M. JONES. Nutritional disorders. L. S. McKINSTRICK. Cancer of rectum. E. L. YOUNG, Jr. Cancer of colon. J. V. MILES and F. W. HOTT. Rupture of Graafian follicle and corpus luteum. R. H. WALLACE. Treatment of burns.
- W. J. MYRTLE, JOHN HODGSON and associates—2. Neurosurgical clinic.
- V. H. KASABJIAN, E. M. DALAND and associates—2. Plastic surgery clinic.
- T. R. GORTALS and associates—4. Obstetrical clinic.

## Tuesday

- Staff—p. Operative clinics. General surgical, genito-urinary and thyroid services.
- H. C. MARBLE and T. W. HANCOCK—2. Hand lesions.
- GEORGE HOLMES, A. O. HANCOCK and associates—2. Symposium on the roentgen ray.
- E. D. CRITCHFIELD and associates—2. Surgical research laboratories, demonstration of specimens and discussions.
- M. N. SMITH-PETERSEN and associates—2. Orthopedic clinic.
- Either Day exercises—4.

## Wednesday

- Staff—p. Operative clinics, general surgical, fracture and circulatory services.
- Staff—2. Dry clinic. D. KIRO. Postoperative pulmonary complications. H. BRADSHAW. Methods in anesthesia. H. SARGENT. Surgery in cardiac patients. L. S. McKINSTRICK and R. H. MILLER. Ulcerative colitis. E. D. CRITCHFIELD. Cardiology. E. B. BACKUS. Gastroscopy. R. H. MILLER. Osteomyelitis.
- J. V. MILES, F. ALABRIGHT and associates—2. Ovarian dysfunction clinic.
- P. D. WILSON, A. W. ALLEN, G. A. LELAND and associates—2. Fracture clinic.

## Thursday

- E. A. COOMAN and associates—p. Symposium on lesions of the shoulder.
- Staff—p. Operative clinics, general surgical and thoracic services.
- T. B. MALLORY—12. Clinical pathological conference.
- E. D. CRITCHFIELD, W. WHITTEMORE and associates—2. Thoracic surgery clinic.
- A. W. ALLEN and associates—2. Circulatory diseases clinic.
- C. C. SARGENT and associates—2. Tumor clinic: cancer symposium.

## Friday

- Staff—p. Operative clinics, general surgical and orthopedic services, neurological operations, plastic surgery.
- Staff—2. Dry clinic. C. LYONS. Sybiotic infections. B. VINCENT and A. V. BOCK. Surgery of spleen. A. W. ALLEN. Regional felicitis. R. H. MILLER. Tuberculosis of the lymphatic system. R. LINTON. Portal circulation. R. H. SUTTERWICK. Significance of negative

Graham tests. OLIVER CORP. Subject to be announced. H. ROGERS. Malignant struma.

- J. H. MEARS, A. W. ALLEN, E. D. CRITCHFIELD, R. H. MILLER, E. L. YOUNG, Jr. and associates—2. Diseases of the thyroid and parathyroid.
- J. D. BARKER and associates—2. Genito-urinary surgery.

## PETER BENT BRIGHAM HOSPITAL

## Monday

- DAVID CHEEVER—2. Surgical clinic.
- H. P. NEWTON—3. Thoracoplasty.
- S. A. LINTON—3:30. Circulatory emergencies in surgical patients.

## Tuesday

- Staff—p. General surgery, operative clinic.
- E. C. CUTLER—2. Total thyroidectomy.
- C. L. DENNEY—3. Symptoms and diagnosis of vascular thrombosis.
- JOHN HOSKINS—3:30. Swollen legs.

## Wednesday

- Staff—p. General surgery, operative clinic.
- HENRY A. CHRISTIAN—4. Medical clinic.
- M. C. SOMMER—3. Recent developments in diagnostic radiology.
- E. S. ENCKY JR.—3:30. Results of surgical procedures for relief of peptic ulcer.

## Thursday

- Staff—p. General surgery, operative clinic.
- W. C. QUINN—2. Indications for and results of total cystectomy.
- J. C. ECKOLS and G. P. GRANTFIELD—3:30. Desmery ted kidney studied by means of the divided bladder.
- M. S. STROCK—3. Methods of fixation of fractures of the jaw.
- S. B. WOLSKIN—3:30. Demonstration of surgical pathology.

## Friday

- Staff—p. General surgery, operative clinic.
- DAVID CHEEVER—2. Cancer of the stomach.
- F. C. NEWTON—2:30. Cancer of the rectum.
- R. FITZ—3. Function of the spleen.
- W. P. MURPHY—3:30. Treatment of pernicious anemia, motion picture demonstration.
- F. R. ORR—3:45. Treatment of neuromuscular sequelae of pernicious anemia.

## MASSACHUSETTS WOMEN'S HOSPITAL

## Thursday

- HENRY T. HUTCHINGS—p. Pankystectomy.
- STEPHEN RUDOLPH—p. Plastic laparotomy.
- WILLIAM A. WHITE, JR.—p. Laparotomy.
- REINHOLD MARGENSON—p. Transverse cervical Cesarean section.
- ROBERT L. MARSH—p. Thyroidectomy.
- Staff—2. Dry clinic. CHARLES H. LAWRENCE. Endocrine sterility, end-results. DONALD MACGIBBIN. Problems of sterility. CHARLES F. PANDYER. Congenital obturator dislocation of right hip: causes of eversion of bone. J. STEWART ROONEY. Discussion of pathological specimens.

## BOSTON CITY HOSPITAL

## Monday

Staff—2. Dry clinic. J J REGAN S WEISS and D MUM  
20 The eye in arteriosclerosis, hypertension and  
tumor G K COONER Treatment of shock. J RES-  
NIE and M. RITVO Pellegri-Stella's disease, diag-  
nosis and treatment. O J HERMANN and E. PARKER,  
Jr. Synovitis of knee. F A. SLOWICK Septic hips.

## Tuesday

DAVID D SCANKELL, SOMERS FRASER, THOMAS W  
WHIGHAM and JOHN A. SETH—p. General surgical  
dry clinic.

First Surgical Service—p. General surgical operative  
clinic. HORACE BINNEY Thoracoplasty for unilateral  
phthisis, phrenicectomy for unilateral phthisis.  
JAMES J HERBURN Repair of ventral hernia gastric  
ulcer. GEORGE W PAPER Chronic empyema  
cholecystitis.

Fifth Surgical Service—2. Dry clinic. IRVING J WALKER  
Some surgical aspects of jaundice—hyperparathyroid-  
ism, end-results, repair of common duct chondrosar-  
coma of humerus, end result carcinoma of stomach  
end-result ligation of common carotid artery end-  
result. FRANCIS F HENDERSON Carcinoma of lung  
pancreatitis, review of sixty cases. AUGUSTUS RILEY  
Prostate and vesicles as foci for retroperitoneal infec-  
tion kidney resections demonstration of cases.  
CHARLES C LUND Peripheral arterial embolism, re-  
sults of operative treatment on fifteen cases. E.  
EVERETT O'NEIL. Breast tumors, clinical versus  
X ray diagnosis. WILLIAM A. WHITE Subject to be  
announced.

ROBERT M. GREEN, JOHN T. WILLIAMS, FREDERICK L.  
GOOD, JOSEPH P. CORNELL and associates—3. Gynecol-  
ogical and obstetrical dry clinic Treatment of mis-  
carriages puerperal sepsis pelvic inflammation.

## Wednesday

IRVING J WALKER, FRANCIS F HENDERSON CHARLES C  
LUND, E. EVERETT O'NEIL and WILLIAM A. WHITE  
—p. General surgery operative clinic.

Bone and joint service—p. Dry clinic. OTTO J HERMANN  
Boston City Hospital bone and joint service. THOMAS  
H. PETERSON Colles fracture therapy Soutter trac-  
tion in unreduced fractures of the forearm and old  
shoulder dislocations. GEORGE K. COONER Fracture  
of the olecranon, new operative repair OTTO J  
HERMANN Recurrent shoulder dislocations repaired  
by the Nikola method end results, discussion. WIL-  
LIAM F COTTING and MARK H. ROGERS Subdeltoid  
bursitis. MARK H. ROGERS Rupture of supraspinatus  
tendon, discussion. JOSEPH H. SHORTELL Spinal  
fracture, therapy RUSSELL F SULLIVAN Spinal  
fusions. OTTO J HERMANN Compound fracture  
therapy FRANK W MARVIN Anesthesia in frac-  
tures

First surgical service—2. Dry clinic. NEWTON C. BROW-  
DER Results of treatment of Colles fracture modern  
splinting methods in fracture therapy JAMES J HER-  
BURN Results in treatment of peptic ulcer giant-cell  
sarcoma of bone treatment of ventral hernia. HORACE  
BINNEY Methods and results in treatment of acute  
empyema, lung abscess, bronchiectasis, pulmonary  
tuberculosis. GEORGE W PAPER Methods and re-  
sults in treatment of chronic empyema.

Sixth surgical service—2. Dry clinic. JAMES W SEVER  
Separation of femoral epiphysis. MARK H. ROGERS  
Ankylosed hips. OTTO J HERMANN Treatment of

intracapsular fractures of neck of femur demonstra-  
tion of cases of recent fractures and ununited frac-  
tures. FARMER J COTTON Pelvic fractures. JOSEPH  
H. SHORTELL Bone grafting.

ROBERT M. GREEN, JOHN B. WILLIAMS, FREDERICK L.  
GOOD, JOSEPH P. CORNELL and associates—p. Gynecol-  
ogical and obstetrical operations.

## Thursday

OTTO J HERMANN JOSEPH H. SHORTELL, WILLIAM F  
COTTING RUSSELL F SULLIVAN THOMAS H. PETER-  
SON and G. KENNETH COONER—p. Operative bone  
and joint clinic Ward rounds, demonstration of fracture  
apparatus, etc

Second surgical service—p. ROBERT C. COCHRANE Total  
thyroidectomy for congestive failure and angina,  
parathyroid tumors. WILLIAM R. MORRISON One  
hundred perforated ulcers of the stomach and duo-  
denum from the Boston City Hospital stomach sur-  
gery, motion picture demonstration demonstration  
of following casts—total removal of stomach for can-  
cer with anastomosis of the jejunum to the esophagus,  
hour-glass deformity of the stomach, cholecystec-  
tomy formed by nature. THOMAS K. RICHARDS  
Knee-joint pathology JOHN J. LUCY Recurrent in-  
tussusception caused by intestinal tumor carcinoma  
of the sigmoid. RICHARD L. SMITH Pancreatitis.  
HERBERT H. HOWARD End-results of bilateral renal  
tuberculois, importance of postoperative treatment  
of prostatectomized patient.

Fourth surgical service—2. Dry clinic. ARTHUR R.  
KIMPTON Civillian gas gangrene tetanus, use of  
amniotic liquid concentrate cavernous hemangiomas  
of neck catheter in common bile duct since 1906  
united fractures. EDWARD HARDING Demonstra-  
tion of cases. JOSEPH H. BURNETT Colles fracture  
therapy H. A. BOUVÉ Acute traumatic abdomen.

Sixth surgical service—2. Bone and joint dry clinic.  
WILLIAM F COTTING Gonorrheal arthritis of the  
knee. RUSSELL F SULLIVAN Hallux valgus therapy  
OTTO J HERMANN Fractures of the os calcis fracture  
discussion. JOSEPH H. SHORTELL Bone tumors.  
FREDERICK W O'BRIEN Pre- and postoperative X-ray  
therapy in malignant tumors of the bone. THOMAS  
H. PETERSON Fender fractures.

ROBERT M. GREEN JOHN B. WILLIAMS, FREDERICK L.  
GOOD JOSEPH P. CORNELL and associates—p. Ob-  
stetrical and gynecological operations.

## Friday

ARTHUR R. KIMPTON ROBERT C. COCHRANE, WILLIAM R.  
MORRISON, STEPHEN P. MALLETT and V. H. KAZAN-  
JIAN—p. General surgery, operative clinic.

Staff—p. Gynecological and obstetrical operations.

Staff—3. Dry clinic. J J REGAN and W B. CASTLE The  
eye in anemic patients. STEPHEN P. MALLETT Frac-  
tures of the jaw. WILLIAM R. MORRISON Visualiza-  
tion of arteries and veins for diagnosis and operation  
of aneurysm ligation of the first part of right sub-  
clavian artery and subsequent ligation of innominate  
artery for arteriovenous aneurysm of internal jugular  
vein and subclavian artery OTTO J HERMANN and  
WILLIAM R. MORRISON Chronic subluxation of sternal  
end of clavicle. STEPHEN J MADDOCK Baer maggot  
treatment of chronic osteomyelitis.

Physiotherapy service—p. Dry clinic. JOSEPH REEDIE  
Electrodiagnosis. JOSEPH RESNIE, GRADY W. DICK-  
INSON ARTHUR J. COLE, WALDO W. ROBBINS and  
SIDNEY M. SIMONS Demonstration of cases and  
treatment.

## HARVARD MEDICAL SCHOOL

## Monday

- G. KENNETH COOPER and OTTO AUSTRICK—s (Bldg. C) Demonstration of the mechanical factors controlling the pulmonary circulation.
- CHARLES L. SCUDDER and associates—s (Bldg. F) Symposium on fractures.

## Tuesday

## Building D—s

- GEORGE B. WISLOCKI. Studies in mammalian reproduction.
- VALY MURKIN. Some problems of inflammation related to surgery.
- HENRY G. SCHWARTZ. An experimental study of sympathetic reflexes.
- J. L. BREMER. The postnatal growth of the mammalian lung.
- HAROLD L. WEATHERFORD. The finer changes in the liver cells in anaphylactic shock.
- LESTER S. KING. Some aspects of the hematocerephalic barrier.

## Building E—s

- G. A. BENNETT and WALTER BAUER. Joint changes resulting from trauma.
- HUGH K. WARD. Streptococcal infections.
- CECIL K. DEWEYER. The physiology of the lymphatic system and its bearing on certain problems in surgery.

## Wednesday

## Building C—s

- HALLOWELL DAVIS. Effect of cerebral anoxia on the electrical response of the cortex.
- M. I. GREENHAGEN. The use of hypertonic sacrose solution to reduce cerebrospinal fluid pressure without a secondary rise.
- WALTER B. CANNON. Some relations of the sympathetic nervous system to surgery.

## Building B—s

- DAVID CHEZAR. Surgical anatomy of the abdomen, demonstration on cadaver.

## Building E—s

- FRANK OBER and associates. Orthopedic problems from Children Hospital A. H. BREWSTER. Scoliosis. J. KILBURN. Posture and postural scoliosis. P. NORTON. Posterior transplants. H. FRIEDMAN. Congenital deformities.

## Thursday

- CHARLES L. SCUDDER and associates— (Bldg. E) Symposium on fractures.

## Friday

- Symposium on Industrial Surgery—s—Building C.
- JOSEPH D. ADAMS and W. A. ROOKER. Injuries of the back.
- HENRY MARINE, F. J. CORTY and J. D. ADAMS. Injuries of the nervous system.
- F. J. CORTY and J. H. BENNETT. Colles fracture.

## Orthopedic Clinic—s—Building E

- W. GREEN. Osteomyelitis in infants and children.
- R. H. MORRIS. Septic hips with involved heads.
- A. T. LEO. Osteomyelitis of the tarsus.
- R. JOHNSON. Multiple myeloma.
- A. H. BREWSTER. Personal speech.
- R. H. MORRIS. Knee flexion.

## Daily

Warren Museum—M. CARAVAT, Curator—s

Demonstration of Dwight collection of spines illustrating deformities, anomalies, diseases. Bone tumors, with X-rays, histories, and microscopic slides, with microscopes available for examination (some of these specimens were used in the illustrations in the monograph on Bone Sarcoma issued by the American College of Surgeons). Models showing various types of club feet and effects of operation. Pictures illustrating pathological conditions of bones in Dr. Nichols' collection. Fractures and dislocations of bones as they existed before industrial plants provided so many safeguards. Tuberculosis of bones and joints. Syphilis of bones. Dislocation of ends of bones. Collection of old surgical instruments, obstetrical forceps, turnlays for extracting teeth, urological tools, cupping and leeching instruments.

## BOSTON LYING-IN HOSPITAL

## Tuesday and Thursday

- FREDERICK C. IRVING and associates—p. Obstetrical operations, demonstrations of premature surgery, X-ray department, research laboratories and hospital wards.
- FREDERICK C. IRVING and associates—s. Dry clinic. Fetal roentgenometry; anemia in pregnancy; treatment of heart disease in pregnancy; treatment of diabetes in pregnancy; management of neglected cases of cephalopelvic disproportion; treatment of placenta previa; separation of the symphysis pubis; kidney function tests in pregnancy; classification of the albuminuric and hypertensive conditions in pregnancy; factors which make for viability in premature infants; rhythmolektole fetals; barbiturates and other analgesic drugs in labor.

## EVANGELINE BOOTH MATERNITY HOSPITAL

## Wed. daily

- A. K. PAINE, H. S. FRYER, W. J. McDONALD, M. G. BURLIN, J. HARRIS, D. GOLDFARB, A. A. LEVI, J. J. CONWAY, H. BAKER, S. OROSCO and R. T. PHILLIPS—p. Gynecological operations and obstetrical procedures.

Staff—s. A review by demonstration, charts, pictures and exhibits, of the obstetrical experience of the Booth Hospital. Maternal mortality, factors responsible for the declining rate at the Booth Hospital, the bleeding cases, statistics, management and results, obstetrical sepsis, amniotic, analgesia and anesthesia in labor, results from the standpoint of safety, efficiency, effects on operative incidence. Cesarean section, incidence, indications and mortality; toxemia of pregnancy; treatment methods and results over a fourteen year period; debarking; pterygium; heart disease complicated by pregnancy; fetal mortality; analysis of four hundred cases, pathology.

## HARVARD UNIVERSITY

(Dillon Field House, Soldier's Field)

## Wednesday

- ARTHUR THORNDIKE, JR.—s. Care and prevention of traumatic injuries in athletics; demonstration of protective strapping, padding and apparatus used in modern athletics.

## BETH ISRAEL HOSPITAL

## Monday

Staff—9. Dry clinic. J SEARS Prophylactic vein ligation against embolism from phlebitis of the internal sphenous vein. M BLOOMBERG The prevention of scar tissue by use of bandruche, experimental and clinical experiences, demonstration of cases. W LEVINSKY Intraoperative adhesions. J HERMANSON Transfusions during active bleeding from peptic ulcer. A THURMAN Surgical treatment of cholecystitis. J MIXTER Subacute pancreatitis. J FINEZ Postoperative distention an experimental study

## Tuesday

Staff—9. Symposium on total thyroidectomy for chronic heart disease and angina pectoris. H. BLUMGART Rationale of total thyroidectomy in chronic heart disease. J RISEMAN End results of total thyroidectomy in angina pectoris. D DAVID End results of total thyroidectomy in congestive heart failure. H. BLUMGART Indications and contra indications for surgery selection of cases. C. G. MIXTER General surgical considerations in total thyroidectomy. D BERLIN Technical considerations in total thyroidectomy. DOROTHY GILLIGAN Postoperative parathyroid tetany. D DAVIS Treatment of postoperative complications. J FINEZ A technique for relief of temporary bilateral recurrent nerve injury. A. WEINSTEIN and M. ALTSCHULE Total thyroidectomy motion picture demonstration of cases.

C. G. MIXTER and associates—2 Surgical operations including total thyroidectomy

## Wednesday

C. G. MIXTER and associates—9. Surgical operations. Staff—10.30 Dry clinic. W. DAMESHEK Blood changes in surgical conditions. DR. MORRISON Medical conditions simulating surgical disease. DR. DEROW Significance of postoperative rise in nonprotein nitrogen. ARNOLD STARR and DR. MUELLER Postoperative renal suppression. C. G. MIXTER Surgery of the large intestine. S. CARGILL and DR. FALCON-LEASER Thyroid clinic experiences, demonstration of cases.

E. G. CRABTREE and associates—9. Dry clinic, genitourinary surgery. Symposium on the female bladder. Demonstration of various factors related to function in health, pregnancy and disease. use of urethrogram and cystogram in diagnosis of bladder displacements and deformities in the multiparous woman, results of routine surgery treatment of infections in the abnormal bladder

Staff—3 Dry clinic. C. BEARSE Acute appendicitis beyond age of fifty. W. J. MIXTER Subject to be announced. B. RAPAPORT Comparison on postoperative complications following spinal and general anesthesia. J. FINEZ Relation of diaphragm to the efficiency of cough. L. NASON Gas bacillus infection complicating laparotomy. B. BANKS Differential diagnosis of jaundice. DR. JANKELSON Indications for ileostomy in ulcerative colitis. C. G. MIXTER Regional ileitis. M. BARKIN Is radical resection for carcinoma of rectum the best procedure?

## Thursday

Staff—9. Symposium on total thyroidectomy for chronic heart disease and angina pectoris. H. BLUMGART Rationale of total thyroidectomy in chronic heart disease. J. RISEMAN End-results of total thyroidectomy in angina pectoris. D. DAVIS End-results

of total thyroidectomy in congestive heart failure. H. BLUMGART Indications and contra indications for surgery selection of cases. C. G. MIXTER General surgical considerations in total thyroidectomy. D. BERLIN Technical considerations in total thyroidectomy. DOROTHY GILLIGAN Postoperative parathyroid tetany. D. DAVIS Treatment of postoperative complications. J. FINEZ Technique for relief of temporary bilateral recurrent nerve injury. A. WEINSTEIN and M. ALTSCHULE Total thyroidectomy motion picture demonstration of cases.

C. G. MIXTER and associates—2 Surgical operations including total thyroidectomy

E. G. CRABTREE and associates—2 Bladder surgery operative and dry clinic.

## Friday

C. G. MIXTER and associates—9. General surgical operations.

W. J. MIXTER—9. Craniotomy

MARK H. ROGERS and associates—9. Orthopedic dry clinic Manipulation of subdeltoid bursitis, methods and results slipping epiphysis, femoral neck club foot, demonstration of application of plaster cast method of drainage of septic knee, posterior incision stenosing tenosynovitis, operative results. Nicola operation, end results in cases of recurrent dislocation of shoulder. marble bones, repeated fractures of femur fractures of long bones in Paget's disease. compression fractures of spine in diabetes and old age. correction of hallux valgus, temporary paralysis of sensory nerve affecting the joint.

E. G. CRABTREE and associates—2 Renal surgery

Staff—2 Symposium on tumors. WILLIAM DAMESHEK Malignancy of blood forming organs. L. M. FREEDMAN and H. F. FREEDMAN Laryngeal carcinoma, diagnosis and treatment presentation of cases. R. DAVIDOFF C. G. MIXTER and H. F. FREEDMAN Breast tumors, differential diagnosis, surgical and radiation treatment. DR. SCHLESINGER Diagnosis of malignancy from ascitic and pleural fluids. H. F. FREEDMAN and R. DAVIDOFF Policy toward married women in regard to carcinoma of the uterine cervix. S. A. ROBBINS, E. G. CRABTREE and G. E. PRATHER Renal tumors, roentgen diagnosis, surgical treatment, results. G. E. PRATHER Testicular tumors. J. H. SCHWARTZ and H. F. FREEDMAN Carcinoma of the skin, diagnosis, motion picture demonstration of radium treatment.

## Daily Exhibit in Medical Research Laboratories

Blood changes in surgical conditions. total thyroidectomy for chronic heart disease. renal function tests in surgery demonstration of interesting and unusual X ray films surgical pathological specimens with case histories, photographs, etc.

## STATE PRISON COLONY

## Day to be announced

HILBERT DAY Practice of medicine in a modern correctional institution.

WILFRED BLOOMBERG Psychiatric approach to prison medicine.

HENRY R. CRAIG Unusual incidence of peptic ulcer in a prison population

GEORGE H. LYONS Minor surgical injuries in a protected population.

GEORGE ROTHEBLATT Dental conditions causing personality changes.

## NEW ENGLAND DEACONESS HOSPITAL

## Tuesday

F. H. LANEY, H. M. CLUTE, R. B. CATTELL and R. H. OVERHOLT—*g.* General surgical operations.  
GILBERT HORRAX and JAMES POWERY—*g.* Neurosurgical operations.

RICHARD H. OVERHOLT—*g.* Thoracic surgery operations.  
G. E. HAAGART—*g.* Orthopedic operations.  
JAMES B. HICKS—*g.* Urological operations.  
LINCOLN F. SKEE, PHILIP D. WOODBRIDGE and URRAN EVERHOLT—*g.* Anesthesia.

F. H. LANEY—*g.* Esophageal diverticulum, dry clinic.  
GILBERT HORRAX—*g.* Malignant exophthalmos, dry clinic.  
Staff—*2.* Dry clinics. H. M. CLUTE: Management of obstructive jaundice, exploration of common duct. GILBERT HORRAX: Brain tumors, malignant exophthalmos. SARA M. JORDAN: Gastric cancer and ulcer-gastrojejunal ulcer. F. H. LANEY: Total gastrectomy for cancer-gastrojejunal colic fistula, surgery of intractable ulcer. EVERETT KIEFER: Hemorrhage in peptic ulcer. RICHARD B. CATTELL: Embolectomy-parathyroid tetany.

## Wednesday

F. H. LANEY, H. M. CLUTE, R. B. CATTELL and R. H. OVERHOLT—*g.* General surgical operations.  
GILBERT HORRAX and JAMES POWERY—*g.* Neurosurgical operations.

RICHARD H. OVERHOLT—*g.* Thoracic surgery operations.  
G. E. HAAGART—*g.* Orthopedic operations.  
JAMES B. HICKS—*g.* Urological operations.  
LINCOLN F. SKEE, PHILIP D. WOODBRIDGE and URRAN EVERHOLT—*g.* Anesthesia.

Staff—*2.* Dry clinics. G. E. HAAGART: Subdeltoid bur-sitis, treatment of flexion deformities. JAMES L. PUMPHREY: End-results in trigeminal neuralgia spinal fluid pressure dynamics. FRANK H. LANEY: Esophageal diverticulum hyperthyroidism. H. M. CLUTE: End-results in hyperthyroidism. LEWIS M. HORTSMAN: Thyroidalac patients. EVERETT KIEFER: Ulcerative colitis. RICHARD B. CATTELL: Surgical treatment of ulcerative colitis. RICHARD OVERHOLT: Limited thoracoplasty in pulmonary tuberculosis, cancer of the lung.

## Thursday

E. P. JOSELYN, H. F. ROOT, L. S. MCKITTERICK and T. C. PRATT—*g.* Surgical and medical diabetic ward rounds.  
T. C. PRATT—*g.* 30 Thigh amputation for diabetic gangrene.

L. S. MCKITTERICK—10 30 Critti-Stokes amputation for diabetic gangrene.

Staff—*2.* Dry clinic. Surgery in diabetes mellitus. E. P. JOSELYN: Medical care of the surgical patient. L. RICHARDS: Otolaryngological aspect of diabetes. J. H. WATKINS: Cataract surgery in diabetes mellitus. Gangrene and infection of the lower extremities. H. F. ROOT: Preventive measures. L. S. MCKITTERICK: Factors influencing the level of amputation. T. C. PRATT: Indications for gullotine amputation. R. S. TYLER: Obstetrics in diabetes. MARK ROOZE: Depressed fracture of the spine in diabetes, subdeltoid bursitis in diabetes mellitus.

## Friday

F. H. LANEY, H. M. CLUTE, R. B. CATTELL and R. H. OVERHOLT—*g.* General surgical operations.  
GILBERT HORRAX and JAMES POWERY—*g.* Neurosurgical operations.  
RICHARD H. OVERHOLT—*g.* Thoracic surgery operations.

G. E. HAAGART—*g.* Orthopedic operations.

JAMES B. HICKS—*g.* Urological operations.

LINCOLN F. SKEE, PHILIP D. WOODBRIDGE and URRAN EVERHOLT—*g.* Anesthesia.

Staff—*2.* Dry clinics. R. B. CATTELL: Cancer of the colon and rectum. GILBERT HORRAX: Root resection for trigeminal neuralgia, cordotomy for pain. JAMES POWERY: Spinal cord tumors. RICHARD OVERHOLT: Cancer of the breast. JAMES B. HICKS: Transurethral resection of the prostate. H. M. CLUTE: Schiörrer's disease. F. H. LANEY and FRANK N. ALLAN: Para-thyroid tumors.

## PALMER MEMORIAL HOSPITAL

## Tuesday

Staff—*g.* Treatment of malignant disease including surgery electrosurgery and radium implantation, operative clinic.

Staff—*2.* Dry clinics. G. A. LELAND: Carcinoma of cervix. FLETCHER COLBY: Urinary tract complications from carcinoma of the cervix. L. S. MCKITTERICK: Interstitial irradiation for carcinoma of the breast. R. H. DRENNER: Irradiation of the ovary in cancer of the breast. GEORGE G. SMITH: Diversion of the urinary stream. JOHN HODGSON: Relief of pain in malignant disease.

## Wednesday

Staff—*g.* Treatment of malignant disease including surgery electrosurgery and radium implantation, operative clinic.

## Thursday

Staff—*2.* Dry clinics. D. F. JONES: Surgical management of carcinoma of the rectum. L. S. MCKITTERICK: Factors favoring early diagnosis of cancer of the colon, principles of treatment. R. H. SWEET: Polyps of the colon. SHIELDS WARREN: Pathological aspects of rectal polyp. WYMAN RICHARDSON: Blood dyscrasias after gastrectomy and short-circuiting operations on the intestinal tract.

## Friday

Staff—*g.* Treatment of malignant disease including surgery electrosurgery and radium implantation, operative clinic.

## COLLIS P. HUNTINGTON MEMORIAL HOSPITAL

## Monday

Staff—*2 15.* Tumors and diseases of bones, dry clinic. J. C. AUST: Calcium metabolism in diseases of the bones. CHANDLER C. SHOWNEN: Malignant tumors of bone. RICHARD DRENNER: Radiological diagnosis of bone tumors and certain rare forms of skeletal diseases. C. C. FRANKLIN: The phosphatase determination in bone tumors and skeletal diseases.

GEORGE A. LELAND and J. V. MASON—*2 15.* Carcinoma of the cervix.

## Wednesday

Staff—*2 15.* Carcinoma of the oral mucous membrane, dry clinic. CHANDLER C. SHOWNEN: Choles of treatment in the individual case. C. C. LUND: Results of treatment of cancer of lip. GRANTLEY W. TAYLOR: Carcinoma of the mouth in the female. RICHARD DRENNER: Radiation treatment of oral cancer. CHARLES B. HODGSON: Prophylaxis of cancer of the mouth. SCOTT STURGES: Electrical currents between fillings of different metals as an etiological factor in leucoplakia and cancer of the mouth.

CHANDLER C. SHOWNEN, GRANTLEY W. TAYLOR and RICHARD DRENNER—*2 15.* Cancer of the breast.

# CHILDREN'S HOSPITAL

## Monday

F. R. OZER, W. E. LADD and associates—2. Fractures in children.

## Tuesday

F. R. OZER and associates—9. Orthopedic operations.  
W. E. LADD—9 30. Plastic repair of harelip and cleft palate demonstration of cases, motion picture demonstration.

THOMAS H. LANMAN—10. Acute osteomyelitis in infancy and childhood.

PATRICK J. MAHONEY—10 30. The use of various types of skin grafts in children's surgery.

HENRY HUDSON JR.—11. Acute appendicitis in childhood Meckel's diverticulum.

Staff—2. Operative clinic, surgery in infants and children.

Staff—3. Orthopedic clinic. A. T. LEOG. Early treatment and the prevention of deformities in poliomyelitis. F. R. OZER. Shoulder operations. J. W. SEVER. Stabilization of the ankle joint. M. KATZNER. Tendon transplants. A. T. LEOG. Abductor limp.

## Wednesday

F. R. OZER and associates—9. Orthopedic clinic at Peabody Home.

Staff—9 30. Operative clinic, surgery in infants and children.

W. E. LADD—2. Congenital hypertrophic pyloric stenosis. Intussusception, diagnosis and treatment.

DONALD W. MACCOLLUM—3 30. Treatment of undescended testes, end-results over a 34 year period.

THOMAS H. LANMAN—3. Chronic pulmonary suppuration demonstration of cases.

HENRY HUDSON JR.—3 15. Empyema in childhood, its treatment.

SIMON FARKER—3 30. Surgical pathology of malignant tumors in infancy and childhood followed by demonstration of pathological specimens in department of pathology.

EDWARD C. VOGT—3 45. Roentgenological studies of unusual bone tumors in infancy and childhood.

## Thursday

F. R. OZER and associates—9. Orthopedic operations.

W. E. LADD—9 30. Intestinal atresia, diagnosis and treatment, demonstration of cases, lantern slide demonstration.

PATRICK J. MAHONEY—10. Types of tracheo-esophageal fistula: differential diagnosis and operative treatment congenital and acquired esophageal stricture, demonstration of methods of dilatation.

W. E. LADD—10 30. Atresia of the bile ducts, diagnosis and treatment cholelithiasis, diagnosis and treatment.

THOMAS H. LANMAN—11. Ureteral transplantation for exstrophy of the bladder demonstration of treated cases.

Staff—2. Operative clinic, surgery in infants and children.

Staff—3. Orthopedic dry clinic. A. H. BREWSTER. Claw feet. F. H. MORRIS. Torticollis, mastoid approach. H. FITZSIMMONS. Discussion. F. R. OZER. Semilunar cartilage. H. FITZSIMMONS. Osteoclasts. R. H. MORRIS. Club feet.

## Friday

Staff—9 30. Operative clinic, surgery in infants and children.

Staff—9. Orthopedic clinic. S. M. FITCHER. Cleidocranial dysostosis. F. R. OZER. Shelf operations Sprengel's deformity. S. M. FITCHER. Flexion deformity of the hips. A. T. LEOG. Coxa plana. J. W. SEVER. Orthopedic paralysis.

W. E. LADD—2. Acute and chronic lymphadenitis, demonstration of cases, lantern slide demonstration.

PATRICK J. MAHONEY—3 30. Treatment of fresh burns.

DONALD W. MACCOLLUM—3 45. Treatment of hemangioma by endothermy demonstration of cases.

W. E. LADD—3. Surgical significance of pyuria in infancy and childhood demonstration of cases, lantern slide demonstration.

T. H. LANMAN—3 30. Malignant bladder tumors in childhood.

# CAMBRIDGE CITY HOSPITAL

## Tuesday

H. H. GERMAIN, D. F. MAHONEY, E. J. O'BRIEN, J. J. MURPHY and E. D'ERRICO—9. General surgical clinic, operative and dry. H. H. GERMAIN. Results in surgery of the shoulder nerve suture and skin graft following burn arthroplasty of lower jaw.

D. F. MAHONEY. Fracture of pelvis and humerus.

E. J. O'BRIEN. Results of transurethral resection of prostate massive diverticulum in child 3 1/2 years old results in cases of spina bifida.

F. W. O'BRIEN. Traumatic spine and head injuries demonstration of X ray films.

B. A. GOWEN and WALDO ROBBINS. Orthopedic and fracture clinic.

E. D'ERRICO—2. Injection treatment for varicose veins and ulcers, presentation of cases and motion picture demonstration.

E. DOWNEY—3. Injection treatment of hemorrhoids, demonstration of cases.

## Wednesday

H. H. GERMAIN—9. General surgical operations.

Staff—9. Dry clinic. MAXWELL MACDONALD. Encephalography as an aid to diagnosis in cerebral lesions.

F. G. MINTNER and T. E. DIMAN. Results of accessory sinus operations, demonstration of cases.

R. D. YORVO. Cesarean section. F. J. LYNCH. Subject to be announced later.

J. J. MURPHY. Treatment problems of burns in a general hospital.

J. W. ROCKERT. Oral surgery operations.

ARTHUR SARGENT and WILLIAM LANIGAN. Orthopedic and fracture clinic.

F. O. O'BRIEN. Traumatic spine and head injuries demonstration of X ray films.

J. W. ROCKERT and F. McLEAN. Fractures of lower and upper jaw.

M. SHEA. Arthroplasty of lower jaw.

E. J. O'BRIEN and L. ROCKWELL—10 30. General surgical operations.

E. D'ERRICO—3. Acute torsion of great omentum appendicitis complicating pregnancy.

## Thursday

D. F. MAHONEY—9. General surgical operations.

J. J. MURPHY—10 30. General surgical operations. Problem of rupture of urethra, fracture of pelvis, fracture of femur.

F. O. O'BRIEN—11. Traumatic spine and head injuries, demonstration of X ray films.

# CAMBRIDGE HOSPITAL

## Tuesday

Staff—9. General surgical clinic, operations and demonstration of cases.

Staff—1. General surgery dry clinic.

## Wednesday

J. W. SEVER and associates—9. Fracture clinic.

V. H. KAZANJIAN—9. Corrective clinic, demonstration of fractures.

Staff—3. Fractures, dry clinic.

## ST ELIZABETH'S HOSPITAL

## Tuesday

- JOSEPH STANTON—9 Subtotal thyroidectomy  
 GEORGE KEEHAN—9 Hysterectomy  
 CHARLES KICHAN—9 Supravaginal hysterectomy  
 L. J. O'BRIEN—9 Transurethral resection of prostate gland  
 E. M. HODGINS—10 Repair of portincisional hernia with pedunculated fascial strips, by utilizing sac  
 JOHN SPELLMAN—9 Radical operation for cancer of tongue  
 THOMAS BROOKBUSH—9 Spine fusion  
 BENEDICT BOLAND—11 Low transverse cervical section  
 LAURENCE LOUIS—1 Total thyroidectomy  
 Staff—1 Dry clinic CHARLES KICHAN Series of spontaneous rupture of the uterus RUSSELL SULLIVAN End results of bone and joint problems LAURENCE LOUIS Postoperative total thyroidectomy for (a) angina pectoris, (b) congestive heart disease FRANCIS P. MCCARTHY Frozen sections demonstration and discussion of pathological specimens

## Wed and y

- JOSEPH STANTON—9 Hysterectomy  
 GEORGE KEEHAN—9 Cholecystectomy  
 RUSSELL SULLIVAN—9 Nikols operation for recurrence of dislocation of shoulder  
 LAURENCE LOUIS—9 Radical operation, cancer of breast  
 L. J. O'BRIEN—9 Nephrectomy for tuberculous kidney  
 WILLIAM McDONALD—9 Operation for correction of hildbirth injury  
 THOMAS BROOKBUSH—9 Reconstruction of hip joint  
 M. M. GUTH—9 Removal of cartilage from knee joint  
 EDWARD HODGINS—9 Repair of recurrent inguinal hernia with fascial strips  
 MARTIN SPELLMAN—9 Sacro iliac arthrodesis  
 Staff—1 Dry clinic WILLIAM DOLAN Industrial surgery JOHN W. HARRIS Diseases of the gall bladder medical case either reducing operation or being surgically until demonstration of cases FRANCIS JANTZEN Cholecystitis and liver dysfunction (a) with hypopituitary syndrome (b) with hypothyroid syndrome  
 JOHN L. McCARTHY Flap graft to reconstruction of foot JOHN L. McCARTHY Dissection of spleen from a surgical standpoint THOMAS BROOKBUSH Demonstration of spinal cases with operative technique lantern slides

## Thurs y

- JOSEPH STANTON—9 Gastro-enterostomy  
 BRYANT W. WETTERILL—9 Nephrectomy  
 FRANK JANTZEN—9 Inguinal herniotomy under local anesthesia  
 EDWARD HODGINS—9 Gastro-enterostomy  
 THOMAS BROOKBUSH—9 Reconstruction of hip joint  
 CHARLES KICHAN—9 Prolapsed uterus with perineal repair and suspension  
 WILLIAM DOLAN—11 Suprapubic prostatectomy  
 EDWARD O'BRIEN—9 Suprapubic cystostomy  
 MICHAEL MCCARTHY—9 Fascial repair of double recurrent inguinal hernia  
 BENEDICT BOLAND—9 Tubal plastic for sterility  
 Staff—1 Dry clinic WILLIAM O'HALLORAN Medicine from a pre-operative and postoperative standpoint BRYANT WETTERILL Discussion of diagnosis of carcinoma of bladder WILLIAM McDONALD Polyneuritis in pregnancy JAMES LYNN Vaginal phlebitis complicating pregnancy antenatal JOSEPH STANTON Hypocalcemia of unusual origin, gastric ulcer—demonstration of interesting clinical cases

## BOSTON DISPENSARY

## Tuesday

- Tumor clinic staff—9 Dry clinic FRANK W. MARTIN Anesthesia in operative cases CHARLES M. PROCTOR Precancerous and benign lesions of the oral cavity CHARLES E. DUMAS Radiation technique in malignancy of the throat LEROY A. SCHALL Treatment of cancer of tonsil GEORGE S. SPANER Malignant degeneration of sebaceous cysts LOUIS E. PHARMERY Precancerous lesions and cancer of the cervix, hysteroslide demonstration ALICE ESTEYER Early diagnosis of malignancy of gastro intestinal tract by rebel method HAROLD A. CHAMBERLIN Papillary tumors of the kidney pelvis ROBERT C. GRAVER Management of cancer of penis with particular reference to a modified operation for advanced cases MYRON J. HARRIS Cancer of the prostatic capsule LEONARD OLBY Management of malignancy of the lymphatic system HILBERT F. DAY Cancer of breast, end results of dispensary and personal cases JOHN RODENBERG Bleeding carcinoma of breast without tumor WILLIAM M. SUTTON Management of cancer of rectum with particular reference to irradiation HAROLD McMANUS Relation of pathology department to tumor clinic

## Wednesday

- Staff—9 Dry clinic OLIVER G. TINKHAM Clinical teaching of third year medical students FRANCIS P. BARNUM Use of adhesive plaster P. A. CONNELL Adenomatous changes in aberrant thyroid HILBERT F. DAY Management of a varicose vein clinic, where over 150 treatments a week are given EDWARD T. WHITNEY Varicose ulcers, demonstration of cases and treatment WALTER S. LEVENSON High ligation of varicose veins WILLIAM M. SUTTON Injection treatment of varicoceles S. SEYMOUR HORRICK Results of multiple injections of varicose veins at same visit HILBERT F. DAY Results of excision of sloughs following injection treatment

## Thursday

- Staff—9 Dry clinic JOHN D. ADAMS Stricker-Christian disease (xanthomatosis); bone tumors ROY L. MABREY Chondroma and chondrosarcoma WILLIAM A. HINTON Detection of syphilis as an aid in practice of surgery FRANCIS M. TINKHAM Syphilis and the differential diagnosis of surgical conditions JONAS SKIRRELL Ophthalmic studies in syphilis GRACE E. ROCHFORT In unusual gynecological condition LOUIS A. O. GORDON Pain in the shoulder girdle ROBERT W. BICK Kidney function renal function tests WILLIAM E. DAVIS Some observations in treatment of peptic ulcer in out patient clinic ALICE ESTEYER Diagnosis of acidity of duodenal ulcer by X-ray KATHERINE S. ABERNETHY Hilaris bernalis HILBERT F. DAY Solitary gallstone pain relieved by posture Demonstration of interesting X-ray plates of peptic ulcer and gall bladder disease

## SYDNEY ARLINGTON HOSPITAL

## Tuesday

- F. J. COTTON—9 Bone and joint surgery  
 A. L. BRITT—9 Tumor of the spinal cord, shoulder arthrodesis  
 G. P. TOWLE—9 General surgery  
 S. G. JONES—9 Volkmann's paralysis

## NEWTON HOSPITAL

## Tuesday

- E. D. LEONARD—9. Breast amputation.  
 G. M. MORRISON—9. Reconstruction of elbow.  
 G. K. COOPER—9. Operative treatment of fractured patella.  
 E. G. CRABTREE—9. Cystotomy.  
 F. W. MARVIN—9. Pantocain anesthesia.  
 D. G. NUTTER—9 15. Dermoid cysts of the abdomen.  
 R. I. SMITH—9 30. Carcinoma of the duodenum.  
 G. C. PRATHER—9 30. Renal calculus.  
 V. P. BRACKETT—10. Strangulated hernia in the aged.  
 D. G. NUTTER—10. Hysterectomy for fibroids.  
 G. K. COOPER—10. Triceps repair of olecranon fracture.  
 G. M. MORRISON—10. Ankle fractures.  
 F. R. CLARK—10. Cesarean section.  
 H. WATSON—10 15. Intussusception in infancy.  
 D. G. WILCOX—10 30. Pyosalpinx.  
 E. D. LEONARD—10 45. Paralytic ileus.  
 R. I. SMITH—11. Complete thyroidectomy for angina pectoris.  
 V. P. BRACKETT—11. Cholecystectomy.  
 H. G. DUMPHY—11. Ligation of saphenous vein for varicose ulcer.

Fracture and Orthopedic services—9. Dry clinic. Demonstration of application of plaster casts, Boehler technique application of Anderson well leg traction apparatus treatment of fractures of the spine including hyperextension, frames, jackets, etc. treatment of Colles fracture by Cotton-Loder method demonstration of new type humeral traction abduction splint.

Staff—2. Symposium on obstetrics. E. GRANVILLE CRABTREE. Discussion of urinary tract infection in pregnancy. GEORGE C. PRATHER. Discussion of bone kidneys in pregnancy. F. R. CLARK, M. F. EADES and G. E. MAY. Pre- and postoperative care of patients and complications.

ROBERT G. VANCE—2. X rays of traumatic skulls.

## FAULKNER HOSPITAL

## Wednesday

- F. J. COTTON, E. G. BRACKETT and associates—9. Bone and joint clinic, operative and dry.  
 Staff—2. Dry clinic. E. G. BRACKETT. Hip fracture.  
 F. J. COTTON. Bone tumors fractures of pelvis.  
 H. C. MARBLE. Hand surgery: fractures of the forearm. J. D. ADAMS. Industrial lesions of the knee.  
 WILLIAM A. ROGERS. Compression fracture of spine.  
 E. A. CONMAN. Shoulder lesions. B. GOODYEN. Os calcis fractures. W. F. COTTING. Ankle fractures.

## Thursday

- E. L. YOUNG JR., R. C. COCHRANE, A. R. KEMPTON and associates—9. Operative clinic.  
 J. R. TORBERT and R. S. TITUS—11. Obstetrical clinic.  
 S. W. WIGGON—11. Postoperative pulmonary complications.  
 Staff—2. Dry clinic. H. L. JOHNSON. Amfetin. E. L. YOUNG JR. Immunity in peritoneal cavity. R. C. COCHRANE. Total thyroidectomy. F. G. BALCH, JR. Injection treatment of hemorrhoids. H. K. SOWLES. Elbow fractures. Demonstration of X-ray plates and pathological specimens.

## MASSACHUSETTS MEMORIAL HOSPITAL

## Daily

- Staff—9. Operative clinics.  
 Staff—2. Dry clinics.

## FREE HOSPITAL FOR WOMEN

## Tuesday

- F. A. PEMBERTON, G. V. SMITH and S. C. GRAVES—9. Operative and dry clinic. Carcinoma of cervix uteri, treatment and results, prevention, diagnosis of early cases, relation to cervicitis and its treatment, complications of radium treatment, relief of pain carcinoma of fundus uteri, treatment and results, classification other tumors of uterus, fibroids, adenomyoma.

## Wednesday

- F. A. PEMBERTON, G. V. SMITH and PAUL YOUNG—9. Operative and dry clinic. Tumors of the ovary diagnosis, treatment and results. Cyst adenoma, granulosa cell tumor Brenner tumor teratoma endometriosis, diagnosis and treatment tumors of tubes, round ligaments and vagina.

## Thursday

- G. V. SMITH and JOHN ROCK—9. Operative and dry clinic. Sterility diagnosis, treatment and results. Menorrhagia and metrorrhagia, diagnosis, treatment and results. developments in endocrine research. dysmenorrhea.

## Friday

- F. A. PEMBERTON, E. B. SHEEHAN and S. C. GRAVES—9. Operative and dry clinic. Prolapse, procidentia complete tear of perineum vesico- and recto-vaginal fistula kraurosis vulvae, carcinoma vulvae trichomonas vaginalis tumors of breast, value of X ray treatment.

## NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

## Tuesday

- Staff—9. Surgical operations.  
 Staff—2. Dry clinic. Carcinoma of fundus in young woman treated for amenorrhea with antaltin S. fibrosarcoma of liver in six year old child. carcinoma of kidney with metastasis in three year old child. unusual pathological specimens with case histories.

## Wednesday

- Staff—9. Surgical operations.  
 Staff—9. Obstetrical analgesia with demonstration of cases ward rounds prenatal clinic parent teaching clinic.

## Thursday

- Staff—9. Surgical operations.  
 Staff—9. Orthopedic operations demonstration of unusual case of fractured pelvis.  
 MIRIAM KATZOFF—9. Familial muscular dystrophy.

## Friday

- Staff—9. Surgical operations.

## CARNEY HOSPITAL

## Daily

- F. B. LUND and associates—9. General surgical operations.  
 L. E. PRATT and associates—9. Gynecological and obstetrical operations.  
 W. R. MACLELAND and associates—9. Orthopedic operations.  
 R. S. GRAVES and associates—9. Urological operations.  
 Staff—2 15. Dry clinics.



## ROBERT B BRIGHAM HOSPITAL

## Monday

- L. M. SPEAR—2. Classification of types of arthritis.  
L. T. SWAIN and J. ROBERTS—3. Treatment and orthopedic principles involved in arthritis.

## Tuesday

- H. K. THOMPSON—2. Clinical analysis of arthritis with reference to classification and treatment.  
P. D. WILSON and S. ROBERTS—3. Discussion of operative procedures, demonstration of end-results.

## Wednesday

- L. M. SPEAR—2. Classification of types of arthritis.  
L. T. SWAIN and J. ROBERTS—3. Treatment and orthopedic principles involved in arthritis.

## Thursday

- H. K. THOMPSON—2. Clinical analysis of arthritis with reference to classification and treatment.  
P. D. WILSON and S. ROBERTS—3. Discussion of operative procedures, demonstration of end-results.

## MALDEN HOSPITAL

## Wednesday

- L. E. PHAYLEY and N. A. GALLAGHER—9. Gynecological operations.  
R. SULLIVAN—9. Orthopedic clinic.  
L. W. McQUINN—9. Aesthetic dentistry and its complications.  
C. F. LEACH, D. J. DOUGAN, I. J. WALKER and F. W. GAY—2. Surgical operations.  
Staff—2. Dry clinic. J. S. ROONEY. Pathological demonstration. I. J. WALKER. Discussion of jaundice with demonstration of liver specimens. L. SILVA. Discussion of coronary and gall-bladder disease in middle-aged people with electrocardiographic tracings. C. H. STANLEY. Hyperparathyroidism with demonstration of cases.

## PONDVILLE STATE CANCER HOSPITAL

## Tuesday—2 p.m.

- ERNEST M. DALAND. The Massachusetts cancer program.  
HENRY JACKSON JR. Some aspects of malignant lymphoma.  
JOE V. MILES. Ovarian tumors.  
LAWSON PARSONS. Treatment of cancer of the cervix by X-ray followed by radium.  
ROGER GRAVES. Cancer of the prostate with metastases.  
CHARLES KICHAM. Cancer of the penis.

## Friday—2 p.m.

- GRANTLEY TAYLOR. Radium needles in cancer of breast.  
HORATIO ROGERS. Chronic cystic mastitis.  
RICHARD DRENNER. X-ray in the diagnosis of gastrointestinal cancer.  
SHIELDS WARREN. Changes in tumor tissue caused by radiation.  
JOHN HODGSON. Treatment of pain in cancer patients.  
CARL EDWARDS. Cancer of the antrum.

## WALTHAM HOSPITAL

## Friday

- R. L. DENORMANDE, T. W. HARRIS, D. MURPHY, J. D. BARKETT, J. W. SEVER, H. Q. GALLUPE, R. COLLINS and H. A. WOOD—9. Surgical operations.  
R. L. DENORMANDE, T. W. HARRIS, D. MURPHY, J. D. BARKETT, J. W. SEVER, H. Q. GALLUPE, R. COLLINS and H. A. WOOD—2. Dry clinics. General surgery, orthopedics, obstetrics, pathology, etc.

## NEW ENGLAND BAPTIST HOSPITAL

## Tuesday

- HAILEY B. LONER—9. Operative clinic.  
Staff—9. Dry clinic. HAILEY B. LONER. Portal thrombosis, ulcerative colitis, gall stones, pancreatitis; uterine fibroids. A. A. HOSKINS. Ulcerative colitis. ROBERT L. DENORMANDE and DELOS J. BARKETT. Blood transfusion in obstetrics, management of borderline obstetrical cases, anesthesia and analgesia in obstetrics, prevention of eclampsia.

## Thursday

- F. H. LARKY, H. M. CLUTE, R. B. CATTILL and R. H. OYERBOLT—9. General surgery operative clinic.  
CHUBERT HORRAX and JAMES POFFER—9. Neurosurgical operations.  
G. E. HAGGART—9. Orthopedic surgery.  
JAMES B. HICKS—9. Urological surgery.  
LINCOLN F. SISK, PHILIP D. WOODBRIDGE and URSAN EYERBOLT—9. Anesthesia.

## CHELSEA MEMORIAL HOSPITAL

## Thursday

- Staff—9. Dry clinic. CHARLES P. SHIELDS. Septic abscesses. LAWRELLYN H. ROCKWELL. Perforated duodenal ulcer. GEORGE A. MARIN. Acute appendicitis with peritonitis. SYLVESTER B. KILLEY. Cases of death in prostaticitis.  
Staff—2. General surgical operations.  
Staff—2. Dry clinic. GORDON MORRISON. Abdominal trauma. G. STEPHEN JONES. Volkmann's contracture. ALEXANDER P. ATTEN. Epiphyseal separation of the radius. JOHN S. HODGSON. Fractures of the skull. Discussion by FREDERICK J. COTTON.

## LONG ISLAND HOSPITAL

## Wednesday

- R. H. MORRIS and T. H. PETERSON—9. Fracture demonstration.  
H. R. VIETH—9. Neurosurgical diagnosis.  
J. H. CUNYHAM and C. S. SWAN—9. Urological operations.  
A. S. MACMILLAN—2. X-ray demonstration.  
I. B. ARKINSON—2. Pathological demonstration.  
C. L. SWAN, R. L. SMITH and T. C. PRATT—3. General surgical operations.

## LAKEVILLE SANATORIUM

## Wednesday

- Z. B. ADAMS—9.30. Ankylosis of hip, operative. Ward rounds.  
Staff—2. Dry clinic. Tuberculosis of lymph nodes, gastro-intestinal tract, eye, gastro-intestinal tract, peritonitis, and skin.  
Z. B. ADAMS—2. Orthopedic dry clinic.

## INDUSTRIAL SURGERY

## Tuesday

- H. C. MARBLE and H. P. TOWLE (41 Berkeley Street)—9.  
D. LYNN and B. GOODWIN (245 State Street)—9.

## Wednesday

- O. W. MORSE (31 St. James Avenue)—9.

## Thursday

- WILLIAM DOGAN (110 Milk Street)—9.

## Friday

- J. H. SHORTELL (260 Tremont Street)—9.  
D. LYNN and B. GOODWIN (245 State Street)—9.

# SURGERY OF THE EYE, EAR, NOSE AND THROAT

## MASSACHUSETTS EYE AND EAR INFIRMARY OPHTHALMOLOGICAL SECTION

### Monday

Staff—3 Ophthalmological operations.  
VINCE G. CASTER—2 Visual fields in neurological cases.  
T. L. TERRY—2. Pathological demonstrations.

### Tuesday

H. B. C. RIEGER and assistant—9 Ophthalmological operations.  
DR. BODELL—9. Technique of photographing the fundus.  
F. H. VERBOFF and assistant—9. Ophthalmological clinic.

### Wednesday

J. HERBERT WHITE and assistant—9. Ophthalmological operations.  
DR. BODELL—9. Technique of photographing the fundus.  
F. H. VERBOFF and assistant—9. Ophthalmological clinic.  
ALLEN GREENWOOD—3. Fundus cases.  
T. L. TERRY—3. Pathological demonstration  
Staff—2. Ophthalmological operations. Motion pictures of operations.

### Thursday

EDWARD K. ELLIS and assistant—9. Ophthalmological operations.  
H. B. C. RIEGER—9. External diseases of the eye.  
J. J. DUMPHY—2. Traumatic injuries, methods of treatment and results.

### Friday

W. HOLBROOK LOWELL and assistant—9. Ophthalmological operations.  
DR. MCCARTHY—9. Color vision testing  
VINCE G. CASTER—3. Ocular paralysis in neurological cases.  
T. L. TERRY—2. Pathological demonstration.  
Staff—3. Ophthalmological operations.

## OTOLARYNGOLOGICAL SECTION

Staff—9 daily Operations and demonstration of cases.

### Dry Clinic—Friday 2

H. P. CAHILL. The present status of brain abscess from the standpoint of the otologist.  
P. E. MELTZER. A twelve year summary of cases of lateral sinus thrombosis at the Infirmary  
P. MITCHELL. A ten year review of cases of labyrinthitis at the Infirmary  
D. C. SMYTH. Chest cases requiring bronchoscopy. Lantern slide demonstration.  
A. S. MACMILLAN and D. C. SMYTH. The accessory sinuses from the standpoint of the roentgenologist and the clinician.  
A. S. MACMILLAN. Petrositis from the X ray standpoint.  
G. H. POMEROY. Result of the Mosher-Toll tear sac operation  
M. H. LURIE. Histological slides showing the pathological condition of the internal ear  
E. W. HERMAN. Radium and X ray treatment of cancer of the larynx.  
H. P. MOSHER. Notes on esophageal cases.  
F. E. GARLAND. Surgery of the submaxillary gland.  
C. G. PAGE. Fungi in tracheal and bronchial mucous.  
G. L. TOBEY JR. The Tobey Ayer test.

## HARVARD MEDICAL SCHOOL

### Monday

H. DAVIS, H. A. DERRBYSHIRE and M. H. LURIE—3 (Bldg C) Demonstration of auditory experiments on the cat—response to sound in the cochlea response to sound in auditory nerve and nerve pathways in the brain.

### Tuesday

H. P. MOSHER—2 (Bldg B) Exhibition of anatomical casts demonstrating the anatomy of the nose and throat discussion of teaching methods demonstration on the cadaver of the submaxillary approach for deep pus in the neck.  
P. E. MELTZER and M. H. LURIE. Exhibition of specimens illustrating the anatomy of the ear

### Daily demonstration

F. E. GARLAND (Bldg B) Demonstration of historical instruments.

## NEW ENGLAND DEACONESS HOSPITAL

### Monday

J. H. WATZ and associate—3 The eye in diabetes.

### Tuesday

WALTER B. HOOVER—9. Osteoma of sinuses laryngeal and tracheal complications of thyroid surgery lingual tonsils and lateral bands of pharyngeal lymphoid tissue syndrome of anemia, glossitis and dysphasia.  
J. H. WATZ and associate—3 The eye in thyroid.

### Wednesday

WALTER B. HOOVER—9 Ear nose and throat operations.

### Friday

WALTER B. HOOVER—9 Ear nose and throat operations.

## BETH ISRAEL HOSPITAL

### Tuesday

Staff—3 Otolaryngological clinic. L. M. FREEDMAN Experiences with vocal cord paralysis in thyroidec-tomy D. J. FINE. Technique for relief of bilateral recurrent nerve injury CHARLES GETTIS. Studies on galvanism in vestibular tests. L. M. FREEDMAN. Jugular puncture in mastoiditis. S. CLINE. Tuberculous laryngitis and its treatment. S. GARFINK. Treatment of malignant tumors of the upper respiratory tract. L. M. FREEDMAN. Bronchoscopic studies.

### Thursday

DR. LEUBMAN and SACHS—10 Eye clinic Cataract extraction muscle advancement. Demonstration of cases.

## FAULKNER HOSPITAL

### Thursday

C. FAUNCE—11 Nose and throat clinic.

## NEW ENGLAND HOSPITAL FOR WOMEN AND CHILDREN

ISABELLA D. KERR. The use of avertin anesthesia in tonsillectomies.  
MARGARET NOTES KLEINERT. Mastoidectomies in infants.

## MASSACHUSETTS MEMORIAL HOSPITAL

*Tuesday*

WILLIAM D. ROWLAND—*g.* Ophthalmological operations.

*Thursday*

Staff—*a.* Ophthalmological clinic.

*Days to be announced*

L. F. JORDON. Bronchoscopic operative clinic.

C. W. BUTER, R. O. PARRIS and B. N. WEIN. Otolaryngological operations.

H. L. BANCROFT. Otolological problems in contagious diseases.

A. W. ROWE and D. W. DREYER. Endocrine factors in deafness.

## BOSTON CITY HOSPITAL

*Monday*

J. J. REGAN, SOMA WEISS and DONALD MUIRO—*3.10.* The eye in arteriosclerosis, hypertension and tumor.

*Thursday*

J. J. REGAN and DONALD MUIRO—*a.* Neurological cases, dry clinic.

*Friday*

J. J. REGAN and staff—*g.* Ophthalmological operations.

J. J. REGAN and WILLIAM B. CASTLE—*a.* The eye in systemic patients.

## BOSTON DISPENSARY

*Wednesday*

HARRY J. DWOLTS and associates—*g.* Dry clinic. LOUIS WOLFSON. Bronchoscopy in the upright position as an out-patient procedure. A. L. CONNOR, F. S. DUREAN and FRANCIS STEIN. An improved method of skin testing in allergic disturbances of nose and throat.

Staff—*g.* The eye and syphilis.

## NEWTON HOSPITAL

OLIVER A. LOYERLY. Tonsil, sinus and septum operations, reduction of recent fractures of the malar and nasal bones, discussion of the indications for mastoid and sinus surgery.

CHARLES L. JORDON, DONALD H. MACDONALD and EDGAR M. HOLMES. Ear, nose and throat operations, demonstration of cases.

## NEW ENGLAND BAPTIST HOSPITAL

*Thursday*

WALTER B. HOOVER—*g.* Ear, nose and throat operations.

## ST. ELIZABETH'S HOSPITAL

*Tuesday*

WILLIAM T. HALEY—*11.* Operation for correction of dislocation of nasal septum.

PETER MACADAMS—*11.* Surgery of the eye.

*Wednesday*

JOHN BURD—*11.* Radical sinus operation under nerve block.

HUGH DONAHUE—*11.* Operation for cataract.

*Thursday*

WILLIAM T. HALEY—*1.* Radical operation for maxillary antrum.

JOHN BURD—*11.* Radical mastoid operation.

## CHILDREN'S HOSPITAL

*Wednesday*

Staff—*g.* Otolaryngological clinic. LYMAN RICHMOND. Acute laryngo-tracheo bronchitis. MAURENCE EVANS. Bilateral jugular ligation and its neurological complications. PHILIP MITCHELL. Cerebral abscess in children. CHESTER MULLA. Sinusitis in children. JONAS E. QUIDLEY. Radical mastoid operation in children. CHARLES ALLMAN. Unusual foreign bodies. ELMER GILLESPIE. Complications in simple mastoidectomy. SAMUEL CLINE. Some cases of sinus thrombosis.

## CAMBRIDGE HOSPITAL

*Thursday*

E. J. BUTLER and C. H. ALLMAN—*g.* Ear, nose and throat clinic, operative and dry. Hematogenous infection of left mastoid with extradural abscess in a nine months old child; pneumococcus type III meningitis with labyrinthitis, demonstration of case.

## CARNEY HOSPITAL

*Daily*

EDWARD D. HURLEY and associates—*g.* Ophthalmological clinics.

F. G. MINTNER and associates—*g.* Otolaryngological clinics.

## CAMBRIDGE CITY HOSPITAL

*Tuesday*

J. W. ROCKEY and T. E. DRYAN—*g.* Tonsillectomies with gas-oxygen anesthesia, presentation of cases of lateral sinus thrombosis.

## LONG ISLAND HOSPITAL

*Tuesday*

V. G. CARTER—*a.* Ophthalmological operations.

# SUBJECT INDEX TO VOLUME LVIII

- ABDOMEN** pressure within, Intra-abdominal pressures created by voluntary muscular effort. Relation to body measurements with a comment on etiology of genital prolapse, 150 Abdominal injuries, 507
- Adhesions**, after burns, The Z plastic or web splitting operation for relief of scar contractures of the extremities, 178
- Alameda County plan**, tr 545
- Ambulance transportation of injured**, The transportation of early long bone fractures the co-ordination of the activities of the committee on fractures of the American College of Surgeons with (a) the American Red Cross, (b) the American Railway Association, (c) ambulances and morticians, 479
- American College of Surgeons**—  
Address of Welcome, 1933, Philip H. Kreuscher 397  
Address of the retiring President, The Hippocratic code and the new deal, J Bentley Squier 407  
Cancer, Organization of a tumor clinic in general hospital, 248, Symposium The curability of cancer 425 Clinics approved to October 1 1933 517  
Candidates, Presentation of class of 1933 423  
Case history, honor list and prize award, 424 Committee on history reviews, 532  
Clinical Congress, 1933 complete transactions, 255-550 Chicago committee on arrangements, 534 Officers elected, 534 Preliminary program, Boston 1934, 1049  
Committee and Department Reports, Committee on the treatment of malignant diseases, 516  
Department of clinical research—Albert J Ochsmers Memorial, 516  
Registry of bone sarcoma, 520  
Committee on fractures, 474, 521  
Board on industrial medicine and traumatic surgery 523  
Committee on undergraduate, graduate, and post graduate teaching of surgery and the surgical specialties, 530  
Board on medical motion pictures, Medical motion picture films, 531  
State and provincial sectional meetings, 531  
The credentials committees and committee on history reviews, 532  
The library and the department of literary research, 533  
Fellowship Address, Back to Galen, Robert Maynard Hitchins, 420  
Fractures, Symposium on treatment of The accomplishments and ideals of the regional fracture committees, 474  
Honorary fellows, Presentation of 423  
Hospital Standardization Conference, The modern philosophy of medicine, 535  
Report of 1933 Conference in Chicago, 538  
Inaugural address, Surgery the queen of the arts, William D Haggard 410  
Industrial Medicine and Traumatic Surgery Conference, 490  
Murphy Oration, The story of a master surgeon, Loyal Davis, 398  
Presidential address, Surgeon of the wilderness—Ephraim McDowell William D Haggard 415
- Regional fracture committee**, The accomplishments and ideals of the, 474
- Anesthesia**, in diabetics, The care of the surgical diabetic a report of 202 cases, 228 department of Organization and management of a, in a 200 to 400 bed hospital, tr 547 Carbon dioxide, the gaseous anesthetics, and the advantages of rebreathing methods of their administration, 711 A safe and satisfactory method of for toxic gutter patients, 737 spinal, an experimental study 852
- Anesthetics**, pantopon, morphine, scopolamine, paraldehyde, pernocton, sodium amytal, pentobarbital, The barbiturates and other hypnotics in labor 1
- Ankle joint**, Epiphyseal separation of the long bones, 85
- Annals of Surgery** A half century of service to surgery ed. 668
- Anterior poliomyelitis**, Sympathectomy in children, 512
- Anus**, crypts of Histopathology of anal crypts, 145 Summary of the end results of treatment of malignancy of the thyroid gland and the colon, including the rectum and, 462 A two stage operation for fistula-in-ano 651  
Strictures of the rectum due to lymphogranuloma inguinale, 827
- Appendicitis**, in children, Acute, in childhood with a critical analysis of 250 cases, 32 Analysis of 100 complicated cases of acute primary cecostomy or enterostomy as a life-saving procedure, 762
- Appendix** Acute appendicitis in childhood with a critical analysis of 250 cases, 32 Analysis of 100 complicated cases of acute appendicitis primary cecostomy or enterostomy as a life-saving procedure, 762
- Arm**, The Z plastic or web splitting operation for relief of scar contractures of the extremities, 178
- Arteries**, surgery of The ligation of large, 287 Tumor of a subcutaneous glomus, tumeur glomique tumeur du glomus neuromyo-artériel, subcutaneous painful tubercle angio-myo-neurome subcutaneous glomus tumor, 807
- Arthritis**, Contusion of cartilage as an etiological factor in chronic, 166
- BARBITURATES** and other hypnotics in labor 1
- Bladder Destruction of the urethra and loss of vesical control associated with vesicovaginal fistula a technique for its correction, 67 Primary carcinoma of the ureter 215 Five year results of suprapubic radium implantation into tumors, 233 Carcinoma of the genito-urinary tract five year cures, 460 Abdominal injuries, 507 Some points in the treatment of genito-urinary tuberculosis, 745 Carcinoma of the, 867  
exstrophy Pregnancy and parturition following bilateral ureteral transplantation for congenital, 1018  
Vesicovaginal fistula and technique of repair 1036
- Blood**, supply of, to bone, Conservation of the circulation in bone and joint surgery ed. 116
- Blood changes in hyperthyroidism**, Parathyroid tumors associated with hyperparathyroidism 11 cases treated by operation, 255
- Blood pressure**, The effects of increased intragastric pressure upon thoracic and abdominal arterial and venous pressures, 699
- Blood supply in injuries**, Rehabilitation of the injured, 511

**Blood vessels.** The venous plexus of the esophagus: its clinical significance, 46. The ligation of large arteries, 387. Thrombo-angitis obliterans: Boerger's disease, 397. Diagnosis and treatment of circulatory disturbances of the extremities, 635. The routine examination of peripheral ed., 669. Tumor of a subcutaneous glomus: tumeur glomique; tumeur du glomus neuromyo-arteriel; subcutaneous painful tubercle; angio-myo-neurome; subcutaneous glomus tumor, 807.

**Bone cysts of.** Cyst formations of the skull, 13. Surgery of. Conservation of the circulation in bone and joint surgery, ed., 116. Fractures of long. Internal fixation of fractures: a simplified (new) method, 194. Long operative lengthening of 318 tumors of. Five year cures in malignant, 471. Long. The transportation of early fractures, the co-ordination of the activities of the committee on fractures of the American College of Surgeons with (a) the American Red Cross (b) the American Railway Association, (c) ambulances and mortuaries, 479. Regeneration of. Experimental studies of reparative costal chondrogenesis and of transplanted, 87.

**Bone lengthening, Operative lengthening of the femur** 38.

**Bone repair.** The aims of medical education in improving the treatment of fractures, 476.

**Bone sarcoma, Registry of,** 380.

**Brain.** Traumatic longitudinal sinus lesions: report of 3 cases, 405. A study of the encephalograms in 97 cases of verified intracranial tumors, 995. Surgery in the treatment of epilepsy, ed., 1041.

**Breast.** Radical excision of the 171. Mastopathia and chronic mastitis, 378. Five year cancer cures, 430. Five year cure of cancer of the at the Massachusetts General Hospital, 437. Cancer of the 438. Carcinoma of the 439. I treatment and results 5, 10, and 15 years after adjuvant amputation, 440. Five year cures in a series of 54 cancers, 443. Cancer of the, a curable disease, 443. Results of radical operation for carcinoma of the 446. Cancer treatment results as shown in 12 year survey at Evanston Hospital, 634.

**Bronchi.** Total removal of left lung for bronchiectasis, 768.

**Bronchiectasis.** Total removal of left lung for 768.

**Buccal mucosa.** Cure of cases with 3 independent cancers occurring in series of cases of buccal cancer, 433. Carcinoma of the an analysis of the cases observed at the Massachusetts General Hospital in the 3 year period, 934-936, 914.

**Boerger disease.** Thrombo-angitis obliterans, 397. The routine examination of peripheral blood vessels, ed., 669.

**Bunion, Operative.** correction of the metatarsus varus primus in hallux valgus, 183.

**Burns, contractures following.** The Z-plastic or web-splitting operation for relief of scar contractures of the extremities, 178.

**CANCER.** The curability of, 435 as a arrestable disease, 446. Five year cures in the south, 437. Five year cures in, 438. Five year cures, 430 of the larynx: its curability by laryngofissure, 431. Cure of cases with 3 independent, occurring in a series of cases of buccal, 433. A group of, cases from private practice, 434. The results in 100 traced cases of 435. A study of 432 cases of on a general surgical service between 1916 and 1926, 436. Five year cures of of the breast at the Massachusetts General Hospital, 437. of the breast, 438. Carcinoma of the breast, surgical treatment and results 5, 10, and 15 years after radical amputation,

440. Five year cures in a series of 54 breast cancers, 443, of the breast—a curable disease, 443. Results of radical operation for carcinoma of the breast, 446. Carcinoma of the cervix uteri: report of 5 year cures by radium in British hospitals, 447. Five year results in the treatment of pelvic, 448. Five year cures of carcinoma of cervix uteri, 450. of the body of the uterus, 453. Carcinoma of the female pelvic organs, 453. of the uterus is curable, 453. Can we increase the percentage of cures in, of the cervix uteri, 456. Five year end-results of the treatment of carcinoma of the cervix, fundus, and ovary, 458. Carcinoma of the genito-urinary tract, five year cures, 460. Summary of the end-results of treatment of malignancy of the thyroid gland and the colon, including the rectum and anus, 463. of the rectum: a study of 5 year cures, 465. Permanent cure of of the thyroid, 468. Five year cures in malignant bone tumors, 471. treatment results as shown in 12 year survey at Evanston Hospital, 634. "precancer" of the cervix uteri: some pertinent observations on its status, 77. Begin at home, ed., 99.

**Cancer clinics approved, to October 1, 1933** tr 57.

**Cancer records in hospitals,** tr 349.

**Carbon dioxide, the gaseous anesthetics, and the advantages of rebreathing methods of their administration,** 711.

**Cardioid, Ilac, case report with obstruction, resection, and recovery** 903.

**Carcinoma, of the breast; surgical treatment and results** 5, 10, and 15 years after radical amputation, 440. Results of radical operation for of the breast, 446. of the cervix uteri: report of 5 year cures by radium in British hospitals, 447. Five year cures of, of cervix uteri, 450. of the female pelvic organs, 453. Five year end-results of the treatment of of the cervix fundus, and ovary, 458. of the genito-urinary tract; 5 year cures, 460; epidermoid. The grading of, 663.

**Carpal bones.** Fracture dislocations of the wrist, 487.

**Cartilage.** Construction of as an etiological factor in chronic arthritis, 66. Regeneration of. Experimental studies of reparative costal chondrogenesis and of transplanted bone, 87.

**Catgut.** The X-ray in the study of the suture, 378.

**Century of Progress,** tr 54.

**Cephalohematomas.** Cyst formations of the skull, 13.

**Cephalometry I.** The X-ray measurement of the fetal head diameter is more an accurate technique by means of stereocentrometry 737. II. The determination of the weight and age of the fetus is more by the aid of stereocentrometry 959.

**Cerebrospinal fluid.** pressure of Spinal anesthesia an experimental study 893.

**Chest.** Cure of cases with 3 independent cancers occurring in a series of cases of buccal cancer, 433. Carcinoma of the buccal mucosa, an analysis of the cases observed at the Massachusetts General Hospital in the 3 year period, 934-1926, 914.

**Chest.** The Z-plastic or web-splitting operation for relief of scar contractures of the extremities, 178. The flap operation for the treatment of acute empyema thoracis, 3061. Thoracic injuries, 503.

**Childbirth.** The pelvic outlet—its practical application, 70.

**Children, diseases of.** Acute appendicitis in childhood with a critical analysis of 290 cases, 31. Sympathectomy in children, 313. Fractures in, Clinical examination versus X-ray examination especially in 485.

**Chondrogenesis.** Experimental studies of reparative costal chondrogenesis and of transplanted bone, 87.

- Circulatory disturbance, Diagnosis and treatment of of the extremities, 655
- Circulatory failure, Acute, as exemplified by shock and hemorrhage, 551
- Circulatory system, The effects of increased intragastric pressure upon thoracic and abdominal arterial and venous pressures, 699
- Clinical and clinicopathological conferences, tr 549
- Clinical Congress, 1933 in Chicago, ed. 395
- Clinical diagnosis of fractures, Clinical examination versus X-ray examination especially in children 485
- Clinical laboratories, Standardization of 516 The organization, management, and functioning of the, tr 548
- Coley, Robert Calvin, 671
- Coley's toxins, Five year cures in malignant bone tumors, 471
- Colon, The diagnostic value of the double contrast enema with special reference to the diagnosis of early neoplastic lesions of the, 51 Five year cancer cures, 430 Summary of the end results of treatment of malignancy of the thyroid gland and the, including the rectum and anus, 463
- Compensation laws, A 3 years survey of medicine and surgery in industry: including legislative enactments and other indemnity problems, 493 Preventive health measures in industry as revealed in a 3 years survey 496
- Commission on medical education, The Hippocratic code and the new deal, 407
- Committee on costs of medical care, The Hippocratic code and the new deal, 407
- Convalescent care for the patient, tr 547
- Cranium, Cyst formations of the skull, 12 tumors within, A study of the ventriculograms in 97 cases of verified intracranial tumors, 995
- Crypts of Morgagni Histopathology of anal crypts, 145
- Cures in cancer The curability of cancer 435
- Cysts of cranium Cyst formations of the skull, 12
- DIABETES**, Surgery in The care of the surgical diabetic a report of 303 cases, 238
- Diagnosis, differential, Double contrast enema in, The diagnostic value of the double contrast enema with special reference to the diagnosis of early neoplastic lesions of the colon, 51
- Disease, neurogenic, Hyperthyroidism and associated diseases, 272 Cancer as an arrestable disease, 436
- Dressings, standardized ready made, The advantages of tr 546
- Duodenal fistula, Conservative treatment of acute 786
- Duodenum, Chronic follicular gastritis, 614 Conservative treatment of acute duodenal fistula, 786 The status of "Billroth No. 1" in the surgery of stomach and ed. 917
- EARLY** American Hospitals, "Old Blockley" 797 A short history of the Massachusetts General Hospital 421
- Early American Medical Schools, The Medical Department of the University of Buffalo 120 Transylvania 1044
- Economics, in otolaryngology 393
- Education, medical, Back to Galen 420 Preparation for a surgical career tr 541
- Electrosurgery Severing adhesions in artificial pneumothorax by the electrosurgical method, 619
- Ehott method, Heat in treatment of pelvic inflammation, ed. 239
- Embryo, I. The X-ray measurement of fetal head diameter in situ an accurate technique by means of stereocent

- genometry 737 II. The determination of the weight and age of the fetus *in vitro* by the aid of stereocent genometry 959 An early human, *in situ* 968
- Endocrine glands, The etiology of uterine fibroids with special reference to the frequency of their occurrence in the negro an hypothesis, 57
- Enterogenous cysts report of 3 cases associated with the rectum, 1037
- Epididymis, Some points in the treatment of genito-urinary tuberculosis, 745
- Epiptosis, The curability of carcinoma of the larynx, 841
- Epilepsy, Surgery in the treatment of ed. 1041
- Ethelism, Strictures of the rectum due to lymphogranuloma inguinale, 837
- Estrin, hypersecretion of The etiology of uterine fibroids with special reference to the frequency of their occurrence in the negro an hypothesis, 57
- Exercise, Rehabilitation of the injured 511
- Extremities, Diagnosis and treatment of circulatory disturbances of the, 665
- Eye, Removal of orbital tumors, 583
- Eyelids Surgical correction of ocular disfigurements, 390

- FACIAL** defects, Surgical correction of ocular disfigurements, 390
- Fallopian tubes, The surgical treatment of sterility caused by occlusion of the, 741 Fenestration and pouches in the broad ligament as an actual and potential cause of strangulated intra-abdominal hernia, report of 2 cases without strangulation, with review of literature 900
- Family doctor Back to Galen, 420
- Femur Epiphyseal separation of the long bones, 85 Operative lengthening of the, 318 Fractures of the neck of the, 679
- Fibula, Epiphyseal separation of the long bones, 85, An automatic method of treatment for fractures of the tibia and the, 659 Major fractures of the tibia and, an apparatus and a method of treatment, 900
- Fillmore, Millard The Medical Department of the University of Buffalo 120
- Fingers, Tumor of a subcutaneous glomus tumeur glomique tumeur du glomus neuromyo-artériel subcutané ous painful tubercle angio-myo-neurome subcutané ous glomal tumor 807
- First aid in fractures, The transportation of early long bone fractures the co-ordination of the activities of the committee on fractures of the American College of Surgeons with (a) the American Red Cross, (b) the American Railway Association, (c) ambulances and morticians, 479
- Fistula, vesicovaginal, Destruction of the urethra and loss of vesical control associated with, a technique for its correction, 67
- Fistula in-ano A two stage operation for 651
- Five year cures in cancer—See cancer symposium, The curability of cancer 435
- Flint, Austin, The Medical Department of the University of Buffalo, 120
- Fractures, Internal fixation of a simplified (new) method, 104 The accomplishments and ideals of the regional fracture committees, 474 The aims of medical education in improving the treatment of 476 The transportation of early long bone, the co-ordination of the activities of the committee on fractures of the American College of Surgeons with (a) the American Red Cross, (b) the American Railway Association (c) ambulances and morticians, 479 Conduct of after treatment to prevent disability in, 483 Clinical examination versus X-ray examination especially in children 485 disabilities of the wrist, 487 Committee

- on, 521 The importance of accurate and complete records on fracture cases, tr. 550 An automatic method of treatment for the tibia and the fibula, 650, of the neck of the femur 670
- G**ALLEN Back to, 480
- Gangrene of extremities, Thrombo-angitis obliterans, Buerger's disease, 297
- Genito-urinary tract, Primary carcinoma of the ureter 5 Carcinoma of the 5 year cures, 460 Some points in the treatment of genito-urinary tuberculosis, 745
- Glossoma, Tumor of a subcutaneous, tumeur, gliomique-tumeur du glossoma neuromyxo-artériel subcutaneous painful tubercle angio-myxo-neurome subcutaneous glomus tumor 807
- Goutier encephalitic, The prevention of persistent and recurrent hyperthyroidism based on a study of 760 cases of, 590 A safe and satisfactory method of anesthesia for toxic gout patients, 737
- Grading of carcinoma, The grading of epidermoid carcinoma, 903
- Gynecology preventive The pelvic outlet—its practical application, 70
- H**AMORRHAGE, The ligation of large arteries, 287 Acute circulatory failure as exemplified by shock and, 55 Traumatic subarachnoid, The disappearance of blood from the cerebrospinal fluid in, the ineffectiveness of repeated lumbar punctures, 705
- Hemorrhoids, Histopathology of anal crypts, 145
- Hallux valgus, Operative correction of the metatarsus varus primus in, 81
- Health examinations, periodic, Co-operation of railway chief surgeons in the standardization of medical service in industry 5 4 Begin at home, ed. 0 0
- Heart, Hyperthyroidism and associated diseases, 272 Acute circulatory failure as exemplified by shock and hemorrhage, 55
- Heat, in treatment of pelvic inflammation, ed. 330 Rehabilitation of the injured, 5 1
- Hernia, Direct a record of surgical failures, 753 Fenestrate and pouches in the broad ligament as an actual and potential cause of strangulated intra-abdominal, report of cases without strangulation, with review of literature, 906
- Hip, Acute osteomyelitis of the ilium, 936
- Hippocratic code, and the new deal, 407
- Hirschsprung's disease Sympathectomy in children, 318
- Mistamine, Experimental study of the effect of on the healing of gastric defects—artificial gastric ulcer, 136
- Hospital, list of those conducting approved cancer clinics, 5 8 in which departments are conducting approved cancer clinics, 5 9 conducting approved cancer diagnostic clinics, 5 9 Opportunities of the surgeon and the, in promoting community interest in the proper care of the sick, tr. 540 Annual report of, tr. 545
- Hospital care, Maintaining as low hospital charges as are consistent with good care of the patient, from the standpoint of the surgeon, tr. 543 Maintaining as low hospital charges as are consistent with good care of the patient from the standpoint of the radiologist, tr. 543
- Hospital economics, as applied to the small hospital, tr. 543
- Hospital purchase service, The essential principles of the group, tr. 544
- Hospital records, The importance of accurate and complete records on fracture cases, tr. 550
- Hospital standardization, Report of the 1933 conference in Chicago, 538 In small hospital, The application of tr. 545
- Humerus, Epiphyseal separation of the long bones, 85
- Hydronephrosis, The pathogenesis of, 350
- Hyperthyroidism, Parathyroid tumors associated with hyperparathyroidism, 11 cases treated by operation, 255 and associated diseases, 272 The prevention of persistent and recurrent, based on a study of 760 cases of encephalitic gout 590
- Hysterectomy, Supravaginal, a statistical survey of 1900 cases, with especial reference to the later development of carcinoma in the retained cervix, 845
- I**NDUSTRIAL medicine, and traumatic surgery 490, Will, have a place in the National Industrial Recovery Act, 407 Board on, 515
- Industry Preventive health measures in, as revealed in a 3 years survey, 490 medical service in, Co-operation of railway chief surgeons with the standardization of medical service in industry 514, list of approved medical services in, Board on industrial medicine and traumatic surgery 534
- Infections, prevention of in industry A 3 years' survey of medicine and surgery in industry including legislative enactments and other indemnity problems, 491 Pyogenic sepsis, a survey of 150 cases, 886
- Inflammation, pelvic, Heat in treatment of, ed. 330
- Injured In industry Rehabilitation of 311
- Ileus, Relief of acute adhesive intestinal obstruction, by section applied to inflying duodenal tube, ed. 118
- Ilium Acute osteomyelitis of the, 936
- Internat, Hospital standardization and, tr. 543
- Intestine, The diagnostic value of the double contrast enema with special reference to the diagnosis of early neoplastic lesions of the colon, 51; obstruction of, Relief of acute adhesive intestinal obstruction, by section applied to inflying duodenal tube ed. 118 Abdominal injuries, 507 Oxygen pneumoperitoneum in the diagnosis and treatment of tuberculosis of the peritoneum and peritoneum, 567 Analysis of 100 complicated cases of acute appendicitis, primary cecostomy or enterostomy as a life-saving procedure, 757 The carboid case report with obstruction, resection, and recovery 903 Enterogenous cysts; report of 3 cases associated with the rectum, 1027
- Instruments and apparatus, Bausch-Bumpus punch, Caulk punch, Young punch, Transurethral surgery 341 Murphy button, The story of a master surgeon, 398 Anderson splint, An automatic method of treatment for fractures of the tibia and the fibula, 696 Piper's forceps, A plea for prophylactic intervention in the second stage of labor 883, cor. 1048 Grisebald's fractures, Major fractures of the tibia and fibula, as apparatus and a method of treatment, 900
- Insurance, A 3 years' survey of medicine and surgery in industry including legislative enactments and other indemnity problems, 492 Preventive health measures in industry as revealed in a 3 years survey 496
- J**OINT surgery of Conservation of the circulation in bone and joint surgery ed. 1 6
- K**IDNEY calculus of Operative treatment of bilateral nephrolithiasis indications and results, 103; Primary carcinoma of the ureter 215; The pathogenesis of hydronephrosis, 350 Carcinoma of the genito-urinary tract, 5 year cures, 460 Abdominal injuries, 507 Surgical aspects of polycystic, report of 25 surgical cases, 647 Some points in the treatment of genito-urinary tuberculosis, 745
- Knee joint, Contusion of cartilage as an etiological factor in chronic arthritis, 266

- LABOR**, relief of pain in, The barbiturates and other hypnotics in labor 1 The pelvic outlet—its practical application, 70 Relaxation of the pelvic joints in pregnancy 595 A plea for prophylactic intervention in the second stage of labor 883 cor 1048 complications, The determination of the weight and age of the fetus is shown by the aid of stereocentrometry 727 959
- Lactation**, The elimination of morphine and quinine in human milk, 823
- Laryngofissure**, Cancer of the larynx its curability by 431
- Larynx**, Cancer of the, its curability by laryngofissure 431 The curability of carcinoma of the, 841
- Leucocidin**, A new treatment of osteomyelitis preliminary report, 155
- Leucorrhea**, The diagnosis of *Trichomonas vaginalis* vaginitis, preliminary report on a new method 192
- Ligament**, broad, Fenestrate and pouches in the as an actual and potential cause of strangulated intra-abdominal hernia, report of 2 cases without strangulation, with review of literature, 906
- Lip**, Cure of cases with 3 independent cancers occurring in a series of cases of buccal cancer 433
- Liver**, Abdominal injuries, 507
- Long bones**, Epiphyseal separation of the, 85 lengthening of Operative lengthening of the femur 318
- Longitudinal sinus**, Traumatic lesions report of 2 cases, 498
- Lumbar puncture**, The disappearance of blood from the cerebrospinal fluid in traumatic subarachnoid hemorrhage: the ineffectiveness of repeated 705
- Lung**, The flap operation for the treatment of acute emphysema thoracis, 306 Thoracic injuries, 503 Severing adhesions in artificial pneumothorax by the electro-surgical method, 619 Total removal of left, for bronchiectasis, 768
- Lymphogranuloma inguinale**, Strictures of the rectum due to, 827
- MAGGOTS**, use of in osteomyelitis, A new treatment of osteomyelitis preliminary report, 155
- Malignancy**, The curability of cancer, 425 Summary of the end-results of treatment of, of the thyroid gland and the colon, including the rectum and anus, 462 Carcinoma of the bladder 867, grades of, Carcinoma of the bladder 867 The grading of epidermoid carcinoma, 962
- Mammary gland**, Mastopathia and chronic mastitis, 278
- Mammectomies** General Hospital, A short history of the 923
- Master Surgeons of America**, David Prince, 242 Paul Yoer Tupper 921
- Mastitis**, chronic, Mastopathia and 278
- Mastopathia**, and chronic mastitis, 278
- McDowell**, Ephraim, Surgeon of the wilderness, 415
- Medicine**, group The Hippocratic code and the new deal, 407 a 3 years survey of and surgery in industry including legislative enactments and other indemnity problems, 402 Preventive health measures in industry as revealed in a 3 years survey 496 The modern philosophy of 535 The Hospital standardization movement in relation to the practice of internal, 539 The next century of progress in medicine 742
- Medical education**, The aims of in improving the treatment of fractures, 476
- Memoria**, Robert Calvin Coffey 671 Sir William Taylor 795
- Metabolism**, calcium and phosphorus, Parathyroid tumors associated with hyperparathyroidism 11 cases treated by operation 255
- Metatarsus varus primus**, Operative correction of the, in hallux valgus, 183
- Method**, Baer in osteomyelitis, A new treatment of osteomyelitis preliminary report, 155 Elliott, Heat in treatment of pelvic inflammation, ed. 239 electro-surgical, Severing adhesions in artificial pneumothorax by the, 619 Whitman, Albee, Lorenz, Brackett, Boehler Fractures of the neck of the femur 679
- Milk**, human The elimination of morphine and quinine in, 823
- Morphine** The elimination of and quinine in human milk 823
- Mortality** The psychology of operative ed. 238
- Motion picture films**, Medical, 531
- Murphy** John B The story of a master surgeon 308
- Murphy button** The story of a master surgeon, 308
- Muscle**, injuries in childbirth The pelvic outlet—its practical application, 70 biceps brachii, The common syndrome of rupture dislocation and elongation of the long head of the biceps brachii, an analysis of 200 cases, 322 sphincter two stage operation for fistula in-ano 651 sphincter ani, Technique for complete laceration of the perineum, 807
- Musculature**, Intra-abdominal pressures created by voluntary muscular effort, relation to body measurements, with a comment on etiology of genital prolapse 150
- NATIONAL Industrial Recovery Act**, Industrial medicine and traumatic surgery 400 Will industrial medicine and traumatic surgery have a place in the, 491
- Neck**, Congenital torticollis a review and result study 972
- Negro**, malignancy in, The etiology of uterine fibroids with special reference to the frequency of their occurrence in the an hypotheals, 27 cancer in, Five year cancer cures in the south 427
- Nerves**, Tumor of a subcutaneous glomus tumeur glomique tumeur du glomus neuromyo-artériel subcutanéous painful tubercle angio-myo-neurome subcutanéous glomus tumor 807
- New deal**, as applied to medicine, The Hippocratic code and the, 407
- Newborn**, effect of hypnotics on, The barbiturates and other hypnotics in labor 1
- OBSTETRICS**, The barbiturates and other hypnotics in labor 1 Relaxation of the pelvic joints in pregnancy 595 A plea for prophylactic intervention in the second stage of labor 883 cor 1048
- Occupational therapy** Conduct of after treatment to prevent disability in fractures, 482
- Oesophagus**, The venous plexus of the, its clinical significance, 46 Diagnosis and treatment of pharyngo-oesophageal diverticulum, 781
- Old Blockley** 797
- Olecranon** Epiphyseal separation of the long bones, 85
- Operation** Kroenlein, Removal of orbital tumors, 383
- Rovsing** Surgical aspects of polycystic kidney: report of 85 surgical cases, 647 Baldy Webster Fenestrate and pouches in the broad ligament as an actual and potential cause of strangulated intra abdominal hernia report of 2 cases without strangulation, with review of literature, 906, Billroth No 1, The status of in the surgery of stomach and duodenum, ed. 917
- Ophthalmology** Surgical correction of ocular disfigurements, 390
- Orbit**, Removal of orbital tumors, 383
- Ostitis fibrosa**, Cyst formations of the skull, 12
- Osteomyelitis**, A new treatment of preliminary report, 155 Acute, of the ilium, 986
- Otolaryngology** Economics in, 394



- Ovarian follicle, The etiology of uterine fibroids, with special reference to the frequency of their occurrence in the negro, an hypothesis, 57
- Ovarotomy Surgeon of the wilderness—Ephraim McDowell, 415
- Ovary Heat in treatment of pelvic inflammation, ed. 230, Surgeon of the wilderness—Ephraim McDowell, 415
- Five year results in the treatment of pelvic cancer 448
- Five year end results of the treatment of carcinoma of the cervix, fundus, and, 458
- Ovary An early human embryo in it 968

**PARATHYROID gland,** Parathyroid tumors associated with hyperparathyroidism, 11 cases treated by operation, 355

Parturition, Pregnancy and, following bilateral ureteral transplantation for congenital ectrophy of the bladder 1018

Pelvic floor muscles of Intra abdominal pressures created by voluntary muscular effort, relation to body measurements, with a comment on etiology of genital prolapse 50

Pelvis, outlet of The pelvic outlet—its practical application, 70 Heat in treatment of pelvic inflammation, ed. 230 Five year results in the treatment of pelvic cancer 448 Carcinoma of the female pelvic organs, 453 Relaxation of the pelvic joints in pregnancy 595

Perineum Technique for the complete laceration of the 897

Pertoneum, Oxygen peritoneum in the diagnosis and treatment of tuberculous of the genitalia, intestine and, 567

Pharynx, Diagnosis and treatment of pharyngo-oesophageal diverticulum, 78

Philadelphia General Hospital, "Old Blockley" 797

Philosophy The modern of medicine, 535

Physical therapy Conduct of after-treatment to prevent disability in fractures, 482

Physiology of stomach, Experimental studies in gastric, in man, study of pyloric control, the roles of acid and alkali, 935 Gastric lavage in the treatment of pyloric obstruction an experimental study, 956

Pneumectomy Total removal of left lung for bronchiectasis, 768

Pneumoperitoneum, Oxygen, in the diagnosis and treatment of tuberculous of the genitalia, intestine and peritoneum, 567

Pneumothorax, Severing adhesions in artificial by the electrocautery method 619

Precancer of the cervix uteri some pertinent observations on its status, 717

Prince David, 242

Pregnancy, Relaxation of the pelvic joints, in 595 I The X-ray measurement of the fetal head diameter in utero an accurate technique by means of stereoradiography 727 II The determination of the weight and age of the fetus in utero by the aid of stereoradiography 959 An early human embryo in it, 968 and parturition following bilateral ureteral transplantation for congenital ectrophy of the bladder 1018

Prolapse Intra-abdominal pressures created by voluntary muscular effort, relation to body measurements, with a comment on etiology of genital, 50

Prostate, Transurethral surgery 341 The pre-operative treatment of prostatic obstruction, 630

Prostate gland its place in general medicine newer conception of diagnosis and treatment, 377

Psychanalysis, Back to Gales, 430

Psychology of operative mortality ed. 238

Public health agencies, Preventive health measures in industry as revealed in a 3 years survey, 406

Pylorus, Experimental studies in gastric physiology in man, a study of pyloric control, the roles of acid and alkali, 935 Gastric lavage in the treatment of pyloric obstruction an experimental study 956

Pyogenic sepsis, a survey of 150 cases, 886

**QUININE,** The elimination of morphine and, in human milk, 823

**RADIOSENSITIVITY** Carcinoma of the bladder, 867

Radium, Five year results of suprapubic, implantation into bladder tumors, 233 Carcinoma of the cervix uteri report of 5 year cures by in British hospitals, 447 Combined intra-abdominal and intravaginal, treatment in cancer of the cervix, 879

Radius, Epiphyseal separation of the long bones, 85

Fracture disabilities of the wrist, 487

Radon implantation in bladder tumors, Five year results of suprapubic radium implantation into bladder tumors, 233

Railway surgeons, Co-operation of railway chief surgeons with the standardization of medical service in industry 314

Ramification, Sympathectomy in children, 312

Raynaud's disease Diagnosis and treatment of circulatory disturbances of the extremities, 655

Reaction, Frei, Strictures of the rectum due to lymphogranuloma inguinale 827

Rebreathing methods, Carbon dioxide the gaseous anesthetics, and the advantages of rebreathing methods of their administration, 711

Record department of hospital, Plan and scope of the 12 549

Rectum, Five year cancer cures, 430 Summary of the end-results of treatment of malignancy of the thyroid gland and the colon including the, and anus, 483

Cancer of the a study of 5 year cures, 465 Abdominal injuries, 507 A stage operation for fistula-in-ano, 651

Strictures of the duct lymphogranuloma inguinale 827 Technique for complete laceration of the perineum, 897 Enterogenous cysts report of 2 cases associated with the 1007

Rehabilitation of the injured, 511

Respiration Spinal anesthesia an experimental study 852

Ribs, Experimental studies of reparative costal chondrogenesis and of transplanted bone 87

Roentgenography The X-ray in the study of the catgut ligature 578 The X-ray measurement of the fetal head diameter in utero an accurate technique by means of stereoradiography 727, 959

Roentgen-ray examination in fractures, Clinical examination versus X-ray examination especially in children, 485

Roentgentherapy Combined intra-abdominal and intravaginal radium treatment in cancer of the cervix, 879

**SARCOMA,** osteogenic Primary of the thyroid gland report of a case, 100

Scar contractures, The Z-plastic or web splitting operation for relief of the extremities, 38

Scleroderma, Sympathectomy in children, 312

Sepsis, Pyogenic, a survey of 150 cases, 886

Shock, Acute circulatory failure as exemplified by and hemorrhage, 551

Shoulder The common syndrome of rupture, dislocation, and elongation of the long head of the biceps brachii, an analysis of 100 cases, 322

- Shoulder joint, The reduction of old or irreducible dislocations of the, 129
- Sigs, Haeter s, Vergason s, Lodington s, The common syndrome of rupture, dislocation, and elongation of the long head of the biceps brachii: an analysis of 100 cases, 312
- Skull, Traumatic longitudinal sinus lesions: report of 2 cases, 465
- Spastic paralysis, Sympathectomy in children, 312
- Spine, Trauma of the spinal column, 509 Painful lesions of the, ed. 793 Unilateral dislocations of cervical vertebrae without associated fracture, 1007
- Spinal fluid, The disappearance of blood from the cerebrospinal fluid in traumatic subarachnoid hemorrhage: the ineffectiveness of repeated lumbar punctures, 795
- Spleen, Technique of splenectomy, 62 Abdominal injuries, 597
- Staphylococcus in nephrolithiasis, Operative treatment of bilateral nephrolithiasis: Indications and results, 101
- State medicine, Economics in otolaryngology, 394
- Sterility, The surgical treatment of caused by occlusion of the fallopian tubes, 741
- Stereocentrometry I. The X ray measurement of the fetal head diameter *in utero*: an accurate technique by means of stereocentrometry 747, II The determination of the weight and age of the fetus *in utero* by the aid of stereocentrometry 959
- Still's disease, Sympathectomy in children, 312
- Stomach, Polyps of Adenomatous, with special reference to malignant degeneration, 79 ulcer of, Experimental study of the effect of histamine on the healing of gastric defects—artificial gastric ulcer 136 inflammation, Chronic follicular gastritis, 614 dilatation, The effects of increased intragastric pressure upon thoracic and abdominal arterial and venous pressures, 699
- The status of "Billroth No. 1" in the surgery of stomach and duodenum: ed. 917 Experimental studies in gastric physiology in man: a study of pyloric control. The roles of acid and alkali, 935 Gastric lavage in the treatment of pyloric obstruction: an experimental study, 956 Enterogenous cysts: report of a case associated with the rectum, 1027 Indications for operation in gastric syphilis, 1030
- Surgeon, The story of a master, 598 of the wilderness—Ephraim McDowell, 415 Opportunities of the and the hospital in promoting community interest in the proper care of the sick, 754 The healing ed. 1040
- Surgery technique in, Relief of acute adhesive intestinal obstruction by suction applied to intubing duodenal tube, ed. 118 radical, The psychology of operative mortality ed. 138 the queen of the arts, 410 4 3 mortality ed. 138 the queen of the arts, 410 4 3
- years' survey of medicine and in industry including legislative enactments and other indemnity problems 492 teaching of Committee on undergraduate, graduate, and postgraduate teaching of and the surgical specialties, 530 A half century of service to ed. 668 technique in, Carbon dioxide, the gaseous anesthetics, and the advantages of rebreathing methods of their administration 711 technique Concerning the suture, ed. 791 in the treatment of epilepsy ed. 1041
- Sutures, The X ray in the study of the catgut ligature, 578, Concerning the ed. 791
- Sympathectomy in children, 312
- Symphysis pubis, Relaxation of the pelvic joints in pregnancy 595
- Syphilis, Indications for operation in gastric, 1030
- Syphiloma, Strictures of the rectum due to lymphogranuloma inguinale, 827
- TAYLOR, Sir William, 705
- Tests Abraham Zundel, Friedman Rubin The surgical treatment of sterility caused by occlusion of the fallopian tubes, 741
- Thorax, The diaphragm operation for the treatment of acute emphysema, 290 Thoracic injuries, 501 Severely injured persons in artificial pneumothorax by the electric current: a method 619 Experimental studies of repair of vital chondrogenesis and of transplanted bone 41
- Thrombo-angitis obliterans Buerger's disease 297 Diagnosis and treatment of circulatory disturbances of the extremities, 955
- Thymal Permanent cure of cancer of the, 466
- Thyroid gland Primary osteogenic sarcoma of the report of a case 100 Parathyroid tumors associated with hyperparathyroidism 21 cases treated by operation, 2 5 Hyperthyroidism and associated diseases, 272 Summary of the end results of treatment of malignant tumor of the and the colon, including the rectum and anus 492 The prevention of persistent and recurrent hyperthyroidism: based on a study of 769 cases of exophthalmic goiter, 590 A safe and satisfactory method of anesthesia for toxic goiter patients, 737
- Tibia Epiphyseal separation of the long bones, 85 an automatic method of treatment for fractures of the and the tibia 630 Major fractures of the and fibula: an apparatus and a method of treatment 900
- Tobacco, Thrombo-angitis obliterans Buerger's disease, 297
- Torticollis, Congenital, a review and result study 972
- Transportation of injured The transportation of early long bone fractures: the co-ordination of the activities of the committee on fractures of the American College of Surgeons with (a) the American Red Cross, (b) the American Railway Association, (c) Ambulances and mortuaries, 479
- Transurethral 1041
- Trichomonas vaginalis vaginitis, 192
- Tuberculosis, Intestinal, The diagnostic value of the double contrast enema with special reference to the diagnosis of early neoplastic lesions of the colon, 51 Oxygen pneumoperitoneum in the diagnosis and treatment of of the genitalia intestine and peritoneum 567 Some points in the treatment of genito-urinary 745
- Tumor clinic Organization of in a general hospital, 248
- Tupper Paul Yoer 921
- ULNA Epiphyseal separation of the long bones, 85 fracture disabilities of the wrist, 487
- Ureter Primary carcinoma of the, 215 The pathogenesis of hydronephrosis 356 Carcinoma of the genito-urinary tract 5 year cures, 460 Pregnancy and parturition following bilateral ureteral transplantation for congenital ectrophy of the bladder 1018
- Urethra Destruction of the, and loss of vesical control associated with vesicovaginal fistula; a technique for its correction, 67 Transurethral surgery, 341
- Uterus, Fibroids of The etiology of uterine fibroids, with special reference to the frequency of their occurrence in the negro an hypothesis, 57 cancer of Uterine cancer: a report covering the period June 1927 to June 1932 113 Five year cancer cures 430 Five year results in the treatment of pelvic cancer 448, Cancer of the body of the 452 Cancer of the is curable, 455 Five year end results of the treatment of carcinoma of the cervix fundus, and ovary 458 excision, supra vaginal hysterectomy: a statistical survey of 1 2 cases, with special reference to the later development of carcinoma in the retained cervix 845

Uterus, cervix, Carcinoma of the, report of 5 year cures by radium in British hospitals, 447 Five year results in the treatment of pelvic cancer 448 Five year cures of carcinoma of, 450 Can we increase the percentage of cures in cancer of the, 456 Five year end-results of the treatment of carcinoma of the cervix, fundus, and ovary 458 Cancer treatment results as shown in 12 year survey at Evanson Hospital, 634 "Precancer" of the some pertinent observations on its status, 717, Supravaginal hysterectomy a statistical survey of 1900 cases, with especial reference to the later development of carcinoma in the retained cervix, 845 Combined intra-abdominal and intravaginal radium treatment in cancer of the cervix, 879

VAGINA, Destruction of the urethra and loss of vesical control associated with vesicovaginal fistula a technique for its correction 67, The pelvic outlet—its practical application, 70 Technique for complete laceration of the perineum, 897 Reconstruction of the,

employment of the flap transplantation method in one stage with a favorable anatomical result, 982 Vesicovaginal fistula and technique of repair 2036

Vascular disease, The routine examination of peripheral blood vessels, ed. 669

Vasomotor disturbances, Spinal anesthesia; an experimental study, 852

Ventricles, A study of the ventriculograms in 97 cases of verified intracranial tumors, 993

Ventriculograms, A study of the, in 97 cases of verified intracranial tumors, 995

Vertebrae, Unilateral dislocations of cervical vertebrae without associated fracture, 1007

Vulva, Cancer of the, with a report of 118 cases, 1021

WRIST Fracture disabilities of the, 487

Z PLASTIC operation, or web splitting for relief of scar contractures of the extremities, 178

## BOOK REVIEWS

- ADLER, FRANCIS HENRI. *Clinical Physiology of the Eye*, 125
- ARAYA, M. A. *Modern Aspects of Gastro-Enterology*  
With foreword by Arthur F. Hurst, 805
- BICKHAM, WARREN STOVE and SMYTH, CALVIN MASON  
Jr. *Operative Surgery: the Operative Technic In-  
volved in the Operations of General and Special Sur-  
gery*. Vol. vii, 246
- BOTH, WILLIAM. *Surgical Pathology*. 3d thor. rev. ed.  
676
- BRADY, W. RUSSELL. *Diseases of the Nervous System*, 931
- BUCKSTEIN, JACOB. *Annals of Roentgenology: a Series of  
Monographic Atlases*. Vol. x.—Peptic Ulcer. 2d rev.  
ed., 245
- CANDON, W. B. *Some Modern Extensions of Beaumont's  
Studies on Alexis St. Martin*. Beaumont Foundation  
Lectures, 1047
- CHAPMAN, D. F., and HILL, H. M. *An Elementary Hand-  
book on Radium and its Clinical Use*, 674
- COCKAYNE, E. A. *Inherited Abnormalities of the Skin and  
its Appendages*, 674
- DODSON, MARGARET. *Binocular Vision and the Modern  
Treatment of Squint*, 246
- DORRANCE, GEORGE MORRIS. *Assisted by Enayat Shihraz*  
*The Operative Story of Cleft Palate*, 930
- DOWET, CHARLES, and CREYMER, JEAN. *Bibliothèque du  
Cancer*. *Cancer des Glandes Salivaires*, 127
- FISHER, A. G. TIMBRELL. *Internal Derangements of the  
Knee Joint, their Pathology and Treatment by Mod-  
ern Methods*. 2d ed., 677
- FOLDES, EUGENE. *A New Approach to Dietetic Therapy*  
*Metabolism of Water and Minerals and its Disturb-  
ances*, 674
- FRIY, SIGMUND. *Die Embolie*, 1047
- GELBERMAN, GEORGE. *Gynecology for Nurses*. 2d rev. enl.  
ed., 932
- GLASSER, OTTO, editor. *The Science of Radiology*, 933
- GORDON, R. G., and BROWN, M. FORDSTER. *Paralysis in  
Children*, 932
- HARINGTON, CHARLES ROBERT. *The Thyroid Gland its  
Chemistry and Physiology*, 931
- HEWER, E. E., and SANDER, G. M. *An Introduction to the  
Study of the Nervous System*. 2d ed., 1045
- HOLZMANN, H. *Grundlagen und Praxis der Roentgen-  
strahlendosierung: Dosismessung und Dosisfestset-  
zung*. In collaboration with R. Braun, 1048
- HOLT'S DISEASES OF INFANCY AND CHILDHOOD. A text  
book for the Use of Students and Practitioners. By  
the late L. Emmett Holt and John Howland. Revised  
by L. Emmett Holt, Jr. and Rustin McIntosh, 10th  
ed., 676
- JASCHKE, TUD. TH. V., and PANKOW, O. *Lehrbuch der  
Gynaekologie*. 5th ed., 125
- KELLOOG, EDWARD L. *Hoerber's Surgical Monographs*  
*The Duodenum Its Structure and Function, Its  
Diseases and Their Medical and Surgical Treatment*.  
With a foreword by George David Stewart, 126
- KIRSCHNER, MARTIN. *Operative Surgery: the Abdomen  
and Rectum*. Translation by I. S. Rawdin, 931
- KRUSEN, FRANK HAMMOND. *Light Therapy*. Foreword by  
John A. Kolmer, 245
- LOEHR, W. and JACOBI, W. *Fortschritte auf dem Gebiete  
der Roentgenstrahlen*. Vol. xlv.—Die kombinierte  
Encephal Arteriographie, 247
- LOWER, WILLIAM E. and NICHOLS, BERNARD H. *Roent-  
genographic Studies of the Urinary System*, 675
- MORRIS' HUMAN ANATOMY. A Complete Systematic Trear-  
tise. Edited by C. M. Jackson. 9th ed., 127
- PARSONS, LEONARD G. and BARLING, SEYMOUR. *Diseases  
of Infancy and Childhood*. Vols. i and ii, 805
- ROMANIS, W. H. C., and MITCHELL, PHILIP H. *The  
Science and Practice of Surgery*. 4th ed. vol. I.—  
*General Surgery*. vol. II.—*Regional Surgery*, 126
- ROTHERG, JOHN L. *Ten Years of Obstetrics and Gynec-  
ology in Private Practice: a Clinical Report of 1750  
Obstetrical and 1345 Gynecological Cases, with Com-  
parative Analyses of Many of the Larger Groups, and  
Detailed Case Histories of Some of the More impor-  
tant and Less Common Conditions*, 245
- SELLORS, T. HOLMES. *Modern Surgical Monographs*  
*Surgery of the Thorax*. By T. Holmes Sellors. With  
a preface by R. A. Young, 931
- STEVENS, MARVIN ALLEN and PHELPS, WINTHROP MOR-  
GAN. *The Control of Football Injuries*, 806
- The Practitioners Library of Medicine and Surgery*. Vol.  
IV.—*Nontraumatic Surgery*, 675
- TIDD, NOEL M. *Massage and Remedial Exercises in  
Medical and Surgical Conditions*, 677
- VAN DER SPEK, J. *On Oatogenic Sarcoma*, 932
- VEIT'S HANDBUCH DER GYNAEKOLOGIE. Vol. IV. 2d half —  
*Klinik der gynaekologischen Roentgentherapie*. 1st  
part.—*Die Behandlung der gutartigen Erkrankungen*.  
3d rev. enl. ed. By H. Wintz and F. Wittenbeck, 933
- VEIT'S HANDBUCH DER GYNAEKOLOGIE. Vol. VIII, part 1 —  
*Bauchfellentzündung Genitaltuberkulose Krankheiten  
des Beckenbindegewebes*. Edited by R. Freund, Th.  
Heynemann, G. Linzenmeier, 1047
- VEIT'S HANDBUCH DER GYNAEKOLOGIE. Vol. VIII, part 2 —  
*Die akuten und chronischen Infektionen der Genital-  
organe mit Ausnahme der Tuberkulose und Gonor-  
rhoe*. By C. Bucura, 1048
- WALKER, KENNETH M. *The Enlarged Prostate and Pros-  
tatic Obstruction*. 2d ed., 1047
- WILDEGANS, HANS. *Die Bluttransfusion in Theorie und  
Praxis*, 676



